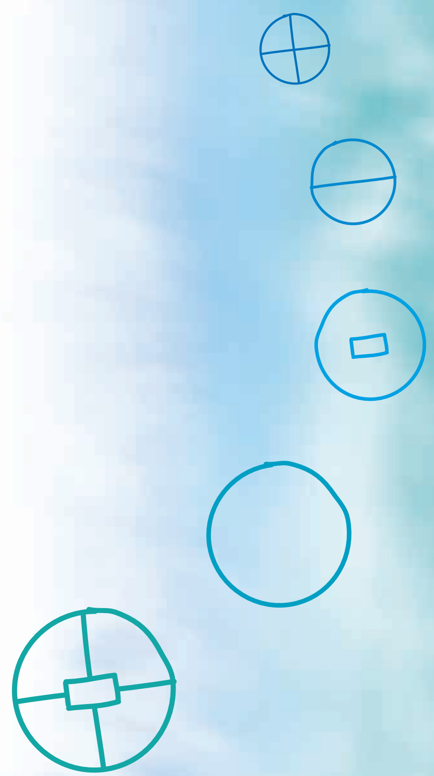
Learners' Guide 7:

recycling

a throw-away book



The Baltic Sea Project

The Baltic Sea Project
Learners' Guide 7 ‚Recycling'
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"EDUCATION FOR SUSTAINABLE DEVELOPMENT"

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Baltic Sea Project – Learners' Guide 7:

recycling

The Baltic Sea Project

Preface from Paris

BSP Learners' Guide no. 7 is particularly timely, as the Baltic Sea Project (BSP) celebrates its 17th anniversary this year (2006), and UNESCO marks its 60 years of existence. In addition, UNESCO is also the focal point of the United Nations Decade for Education for Sustainable Development (2005–2014). The BSP is indeed an outstanding example of how concrete, school-based activities promote this important Decade on all levels: in schools, families, the community, the country, the Baltic region and internationally.

Since the launch of the UNESCO Associated Schools Project Network (ASPnet) in 1953, the Baltic Sea Project was the very first pilot project in which schools in all countries surrounding the Baltic Sea were united by a common cause: to save their Sea. This unifying cause gave students and teachers of all 9 countries bordering on the Baltic Sea the opportunity to carry out joint activities and to get to know each other better. Through this project, teachers and students practised measuring water and air quality, took part in intercultural learning activities and experimented with innovative teaching and learning methods. The participants also held meetings with politicians on key topics of their concern. In fact, through this project, students and teachers were learning about sustainable development before everyone was talking about it! Since 1998, the BSP has served as a unique model for "best practice" in UNESCO ASPnet flagship projects, and as a model for the launching of new projects such as the Western Mediterranean Sea Project, the Caribbean Sea Project, and more recently the Great Volga River Project.

As the global network of UNESCO's Associated Schools has expanded in 2006 to encompass some 7,900 educational institutions in 176 countries worldwide, it is more than ever an ASPnet priority to encourage innovative educational approaches, teaching material and pedagogical methods. In this regard, the achievements of the Baltic Sea Project are impressive: 7 Learners' Guides, with "Recycling" as its latest publication, videos, a regular newsletter, national and regional meetings, are some examples of the outputs of this project. In addition, active learning methods, hands-on activities, field trips, twinning projects with students in other countries, international networking are all forms of the BSP's innovative teaching/learning activities.

One of ASPnet's priorities is to ensure that results of exemplary school-based activities are taken to scale. For this reason, this BSP Learners' Guide no. 7 has the strong support of ASPnet's International Coordination at UNESCO. A great number of the articles in this Guide provide creative, concrete and innovative examples of how to act responsibly while accomplishing simple every day gestures.

I wish to thank all those who made this publication possible including the many BSP participants who contributed as authors, and particularly the international editorial team of this BSP Learners' Guide no. 7.

In line with the BSP Project, this "Recycling" Guide could well influence and change many students' attitudes and values in important ways by encouraging them to take on responsibilities and to go out and take actions to work in their communities, thereby empowering them to be leaders in their community. This Guide is also useful for students and teachers from ASPnet pilot projects in other parts of the world who can benefit from the practical experiences from four continents shared in this Guide.

On issues such as "recycling", it is often the children and students who teach their parents. My hope therefore lies in our children and young people, the future generation, and in their daily decisions and

actions favouring a sustainable planet for them and for generations to come. We can no longer wait: responsible action has to be taken now! And this book is like a guiding star, it shows us the way, provides practical advice and gives us courage.

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Preface from Bonn

Countries around the Baltic Sea have developed, in the last decades, a strong spirit of cooperation based on the common responsibility for a region that was for a long time divided by political barriers but has always been unified by the natural link of the Baltic Sea. Anticipating a new and ever more urgent emphasis of the international political agenda – marked by the Rio and Johannesburg Summits in 1992 and 2002 and by the proclamation of the UN Decade of Education for Sustainable Development (2005-2014) – the "Baltic Sea Project" already in 1989 launched joint international activities for sustainable development by creating a network of schools and teachers of now nine different countries. This project has become a big success. I encourage all those engaged in international networks to take a close look at it and use it as a role model. Main constituents of the effectiveness of this network are, in my view, the strong and passionate commitment of its members and the focus on an up-to-date concept of education for sustainable development.

Education for sustainable development (ESD) is a crucial issue of our time. In the years ahead, we will therefore need to shift it still further from the margins into the heart of our political concerns. Three aspects are important: ESD must be addressed on all levels; neither should it be reduced to a grassroots-problem concentrating only on individual behaviour and personal lifestyles, nor can it be delegated to the policy level of legislation and international normative action alone. Furthermore, we need to develop and teach, in the framework of our educational systems, concepts of competences responding to the increasing global challenges of sustainability. Finally, the concern for sustainable development should not be considered as a realm of retreat for those that reject modernity. It should instead become part of and contribute to evolving the concept of modernity and innovation itself. As Klaus Toepfer, former Executive Director of UNEP (United Nations Environmental Programme), put it: "We need to make sustainable lifestyles fashionable and 'cool' as young people might say".

The present 7th Learners' Guide stands in the tradition of high quality work which has become a standard of the Baltic Sea Project. The Guide is the result of an intense two years of preparation with several meetings and a Summer Camp in 2005 on the old Sailing boat "Passat" in Travemuende, Germany. The cooperation that led to this publication included pupils, teachers, university professors, managers from the private sector as well as artists.

I would like to thank Duales System Deutschland GmbH for generously sponsoring this publication. The German Commission for UNESCO is happy to present this excellent 7th edition of the Learners' Guide. We hope it will contribute to strengthening common reflection and effective action in the Baltic Sea Region and beyond. All those that helped to make this excellent book possible deserve our thanks and appreciation.

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Contents

For mystics during the Middle Ages the four elements (Fire, Water, Air, Earth) and the fifth for the Spirit, already identified by the Greek philosopher Empedokles (about 490–430 b.C.), were given these symbolic signs.

Reference:
BSP Learners' Guide
No. 4 "Rivers" p. 29

To the Reader

Recycling? Why a book about recycling? Why a new BSP Learners' Guide?

This book was made in five steps. We invite you to participate a little following these steps with us.

Realise

In 2003 we realised that "recycling" was a topic the Baltic Sea Project had not explicitly worked on until that time. However, it had very much been a part of the BSP's work in earlier years.

Everything is in a constant flow – in old greek: Panta Rhei.

This old concept underlies and more importantly developed the motto of our book. Awareness and respect towards cycle processes in nature as well as the creation of cycle processes for artificial material of today's sophisticated life – to get away from a throw-away society – is essential for a sustainable life. Education for sustainable development therefore needs education about cycle processes, about recycling opportunities. Indeed a good reason to write an educational book about recycling!

A close contact to people in the Duales System Deutschland GmbH made us think about the idea of making a new BSP Learners' Guide about recycling.

Re-use

The idea of writing a new Learners' Guide on the topic "recycling" came to us at a good time at the end of the three years of Germany – in the person of Ute Grönwoldt as the general coordinator – being the leading country of the Baltic Sea Project. In these three years a great BSP-team had worked together. Why not re-use the energy, the power, the creativity of this team for a great new task? The German BSP schools decided to go into the lead and seriously try. This was in autumn 2003.

Re-think

Much had to be re-thought and many things needed to be considered for this book. A book about recycling is very much a book about sustainable development, and it has thus been enrolled as an official project of the World Decade of the United Nations for Education for Sustainable Development (2005-2014).

Recycling means much more than just material recycling, but of course material recycling is an important part of the topic. Therefore the book starts with an up-to-date article by Hansjörg Nieß on material recycling management. We decided that BSP Learners' Guide no. 7 should have a broad approach, with the contributions in the book focusing on varied aspects of the topic "recycling".

A number of contributions in the book have been written for practice, specially useful for educational work at schools. Others are more scientific, they cope with historic, future-related, economic, cultural, ecologic or even curricular aspects of recycling.

Taking a broad approach also means that editors and especially authors from different regions of the Baltic Sea region could take part in the making of the book.

The authors and editors of this Learners' Guide are not only from the Baltic Sea region, but also from the United States, Uganda, India and New Zealand.

Re-view

How did the ideas and contents develop a BSP Learners' Guide?

Panta Rhei – this motto soon became an essential aspect of our workflow. The initial BSP team soon expanded to as many as eleven editors from five countries and even more authors who have written contributions to this book.

This team has worked together during long conference days and nights in different places, with countless phone-calls and e-mails, struggling for the best concept and the best possible content for this new Learners' Guide. This has been an extremely creative process.

Such a book cannot simply be written from theory. Its contents essentially need practical experience. Therefore the editorial team invited the Baltic Sea Project schools to the BSP summer camp "Panta Rhei – Cycle Processes in Nature", taking place from 18th to 23rd September 2005 in Lübeck-Travemünde, Germany. On board the anchored sailing ship "Passat" 90 participants from all nine BSP countries lived and cooperated in international workshops which had been initiated by the editors of this book.

And now, a year later, the book is ready.

Thanks to the many different authors who have contributed to this book, thanks to Tom Kern and his team for the graphic design, thanks to our well known printing company "Toptryk" in Gråsten/Denmark, thanks to the translators and language correctors, thanks to many, many others for first class support! We would like to very specially thank our sponsor Duales System Deutschland GmbH who have generously supported us and who have been a true partner to us!

Respond!

We hope this book – according to our motto "Panta Rhei" – stimulates you to try out new things. This book is not the final result of a project, it is just a step within a larger process. We therefore hope for your comments and further suggestions.

Please send your response to respond.to.lg7@b-s-p.org. Thank you!

Martin Jarrath und Franz Schürig
on behalf of the Editorial Team
June 2006

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On the sailing ship "Passat", September 2005.
From left to right: Patrick Rump, Franz Schürig, Binya Masuka, Volker Stiehl, Gisela Knipper, Judith Rudolph, Andreas Koch, John Lockley, Stanislav Babitch, Jennifer Lockett.
In front: Ute Grönwoldt, Martin Jarrath, Susanne Mellvig.
(Photo: Lutz Reinecke)

Keynote

Recycling and Education for Sustainable Development: From global perspective to individual action.

by John Lockley

Recycling; an interesting topic perhaps for Learners' Guide no. 7, a book for the Baltic Sea community. Recycling; what does this word bring to your mind as you read it as the title of this book? Are you expecting a book with lots of examples of recycling projects that have been done in different parts of the Baltic Sea region that you might be able to copy and implement on your school or community? Are you expecting a book with lots of scientific background so that after you have read it you will be more informed about the theory of recycling? Whatever your expectation we are hopeful that there will be something in here for you.

We have taken with this book an exploratory position to the topic of Recycling. The Oxford dictionary defines "recycle" in a strict sense as "to convert (waste) into reusable material, or to use again". With this book we have purposely taken a wide definition of the concept of recycling. We have tried to explore the concept from many perspectives. Even in the layout of the book, with chapter headings such as; Realise, Re-use, Re-think, Re-view and Respond we hope will lead to an investigation of recycling in our modern world at many levels. The articles may however leave you with more questions than answers, one of the outcomes of an exploratory approach.

Recycling is something we are all involved in at some level, everyday, in one way or another. We are all involved in material recycling within the earth's ecosystems; the wastes from our own biological lives as well as the materials we use in our lifestyles. Have you ever thought though that we also recycle at a different level? Our ideas and beliefs, our political views and the ways we see the world around us. How much of these are truly our own ideas, and how much is actually recycled thoughts from others? These scales of thought and action, from individual to community and organisational, through to national and international can all be important focuses for understanding our relationship with recycling.

From a global perspective, one view of the world and our relationship to it that is an important backdrop to this book is Environmentally Sustainable Development. This concept came to world recognition as a result of the 1987 world commission on the state of the environment (Brundtland, 1987) where the term was simply defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (p.43). This concept and related ones such as Education for Sustainable Development and Environmental Sustainability have continued to evolve and now flow through most levels of society and are having an effect on the way we organise life on the planet at national and international scales, community and organisational levels as well as informing the choices of individual citizens.

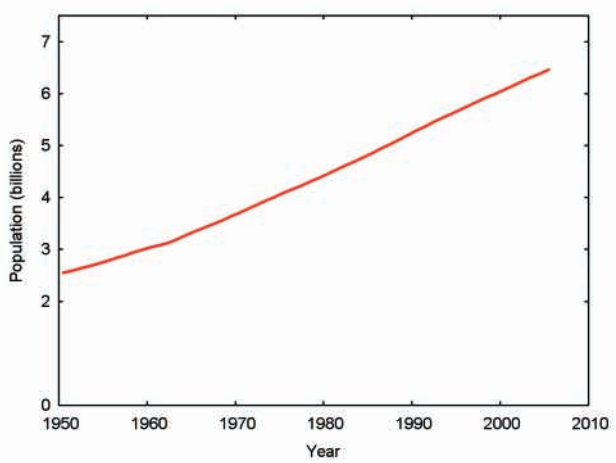
There is an increasing body of evidence indicating that we humans are having a detrimental impact on the natural world. Many reports are indicating that as our population increases and our ways of life become more sophisticated the earth increasingly struggles to supply the resources we need, and to deal with the

wastes we produce on a global scale. In the midst of these reports however, if we look carefully we can see signs of the ideas of sustainable development having an effect.

The worlds' population has been increasing exponentially with the last 70 years of the 20th century showing the largest increase. Predictions for the world's population for the middle of this, the 21st, century have ranged as high as 15 billion but latest estimates (UNFPA, 2005) have been reviewed to only 9 billion. Earlier estimates were based on the presumption that the population would continue to increase at an exponential rate. The indications are now that the population of the earth is increasing at a slower, more linear rate, but still increasing. It is predicted that by the middle of this century we will be sharing the planet, its resources and its waste recycling abilities with 9 billion other people.

Year	Population (Billions)
1802	1
1927	2
1961	3
1974	4
1987	5
1999	6
2010	*6.8*
2020	*7.6*
2030	*8.2*
2040	*8.7*
2050	*8.9*

(Data from the United Nations population fund showing the increase of the world's population over the last 200 years including predictions up to 2050 [shaded figures])

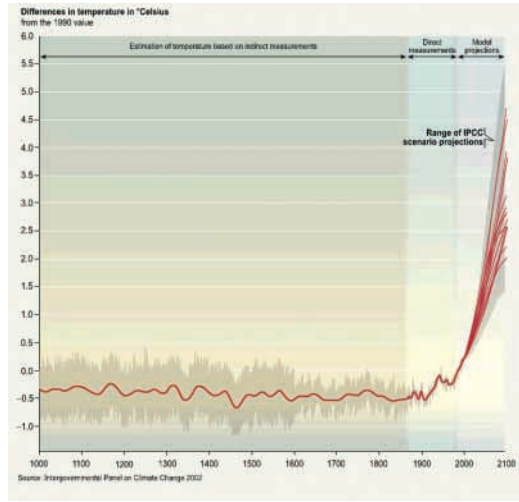


This increasing population pressure is however having wide ranging effects on our world's ability to supply the resources we need and to deal with our wastes; to recycle on a global scale. The United Nations Millennium Ecosystem Report (Millennium Ecosystem Assessment, 2005) was commissioned to investigate the links between the earth's ecosystems, the natural systems that supply and recycle the materials we use to fulfil our lives, and human well-being. The report presents a framework we can use to understand our interrelationships with material flows at a global scale by defining four categories of services that natural ecosystems provide for humans:

- provisioning services such as the supply of food and materials,
- cultural services such as providing recreation and aesthetic enjoyment,
- and importantly in this context supporting and regulating services including the recycling of the outputs of our human lifestyles.

The report concludes that over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history. The changes have occurred largely to meet rapidly growing demands for the resources of human endeavour as our population has increased, food, fresh water, timber, fibre, and fuel. As a consequence we have undergone a period of biodiversity loss on the planet. These changes have though contributed to substantial net gains in human well-being and economic development for many nations. The challenge before us now is to continue the development of human well-being globally but in an ever increasing environmentally sustainable way.

The third line of thought in a global view of recycling comes from the reports of the Intergovernmental Panel on Climate Change (IPCC, 2001) which deal with the earth's capacity to recycle green house gases, a by-product of our technological, fossil fuelled age. The reports give models for the effects of increased greenhouse gases on the climate of the planet. Models of climate change show a predicted rise in atmospheric temperature of several degrees (depending on which model used) over the next three generations.



In a similar manner to predictions about the earth's population, however, it will be interesting to see the scenario unfold. At an international level work has already begun on changing the state of gas emissions with the Kyoto Protocol (United Nations Environment Programme, 1998) now ratified. Perhaps like the definition of Sustainable Development itself, ways of dealing with the greenhouse emissions will evolve over time.

Within the book, we can find articles that connect with these national and international views on recycling. Articles such as;

- "Energy and Climate21: Scenarios for the climate of tomorrow", "Recycling management as an engine of sustainable development" and
- "A can and a bottle; which one has the future?",

investigate the relationship we can have with recycling at these large scales.

As we narrow the focus to communities and organisations articles like;

- "Production of Bio-diesel from waste fryer oil",
- "From municipal waste to a fantasy land" and
- "Car washing: The impact of the activity on a stream and the role of wetlands"

show us how people can engage with concepts of environmental sustainability and make changes towards a more sustainable lifestyle at that level.

Perhaps the most exciting level however is the level of the individual. This is the level where there is the least excuse for change. At this level articles like;

- "Life cycle analysis" and,
- "Recycling cork helps people and cranes"

may be the catalyst to cause us to take action.

Or it may be one of the other articles of the book, which for whatever personal reason challenges you. However you approach this book we certainly hope that you both enjoy the articles and are challenged to some level of response by what you read, whether it is to Realise, Re-use, Re-think, Re-view and most importantly to Respond.

On the BSP Learners' Guide 7 website:
More articles, further information, worksheets
http://www.b-s-p.org/lg7

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The chapter Titles

The chapter titles in this book mirror what the editors feel is a full circle when considering sustainable development and new ways of thinking about production and consumption. Based on the widely accepted waste management hierarchy, reduce, reuse and recycle, we have expanded and modified our titles to emphasize a more holistic approach in the spirit of "**Panta Rhei**"

"In the past we could afford a long gestation period before undertaking major environ mental policy initiatives. Today the time for a well-planned transition to a sustainable system is running out. We may be moving in the right direction, but we are moving too slowly. We are failing in our responsibility to future generations and even the present one."

U.N. Secretary General Kofi Annan, from speech at conference arranged by Bangladesh Institute of International and Strategic Studies, Reuters Planet Ark 14 March 2001

Chapter 1: REALISE

"With Mother Earth in peril, we must seek opportunities in each community to safeguard the environment for all families, now and in the future. Time isn't on our side. Degradation of our planet is occurring rapidly. The only hope we have of rescuing it is our determination to change the course of events by standing together with others and making demands of our leaders."

Susan Jezsik Varlamoff, The Polluters, 1993

Recycling Management as an Engine of Sustainable Development - depicted in the example of Germany

by Hansjörg Nieß

Recycling Management

0 Introduction

The United Nations have declared 2005 – 2014 as the decade for the "Education for Sustainable Development". The aim is to globally promote the integration of the concept of the sustainable development in educating processes.

The sensitisation and inclusion of all those responsible in politics and economics, local authorities, teachers and pupils in this process is a prerequisite for this project's success.

The establishment of a recycling management, that is to say, the finally leaving the throw-away-society, creates a necessary basis for the realisation of a sustainable development. The recycling of packaging is an important component of the recycling economy, because the consumers are actively included in the implementation. This is why particularly the recycling of packaging and the subsequently linked intensive networking of social, ecological and economical components will be presented in the following contribution.

In the cultivation of globally available resources, the construction of recycling management, the concept of waste avoidance plays an important role. Waste avoidance requires an integrated approach: from an ecological point of view, packaging, product, supplier chain and consumer needs form an inseparable unit. Waste avoidance can therefore not be regarded in isolation as a qualitative and quantitative reduction of packaging material but instead must be seen across the entire process chain: from production to distribution and sales right up to consumer usage and subsequent recycling.

Too little packaging – that means packaging, which only inadequately protects the product – has serious consequences on the environment. Lightweight packaging is therefore not inevitably environmentally friendly. Waste avoidance means avoiding the loss of material and energy during the overall process chain. An efficient method of waste avoidance thus consists of measures which are designed to protect products, to optimise packaging as well as to return once utilised raw materials into circulation as material or energy.

"To understand the complexity of environmental issues is a path to sustainable development."

Based on this philosophy, "Duales System Deutschland GmbH" (Dual System Germany Ltd.) and its European "Grüner Punkt" (Green Dot, Logo of Dual System Germany Ltd.) partners in more than 25 European countries, organised under the umbrella organisation, PRO EUROPE, have managed in recent years to enhance popular awareness for the environment. The daily task of waste separation has had an ecological and economic impact on packaging and individual attitudes towards the environment. Environmental education, like education for sustainable development, is based on building awareness and identification with personal living environments. It is therefore not just merely the conveyance of knowledge, but a process of learning about the concept of political action.

1 Recycling Management

Europe is coalescing - also in matters of environment protection. The responsibility of the producers and thus the thinking of the recycling economy have evolved into an integral component of the environ-

International packaging recycling

[1] *http://www.bundesrecht.juris.de/krw-_abfg/index.html*

[2] *http://www.bundesrecht.juris.de/verpackv_1998/index.html*

mental policy in Europe. In contrast to the throughput economy, the recycling economy is understood to be an economic system in which all products are recycled after use. They are mainly returned to the material cycle as material, but also energy, and are utilised there for the manufacture of new products.

1.1 Recycling Management and Waste Avoidance and Management Act (KrW/AbfG[1])

The principle of recycling management in Germany is legally governed. For this, the German Bundestag passed the Recycling Management and Waste Avoidance and Management Act (KrW/AbfG) in 1994. The recycling management law builds on the comprehensive EG waste management concept differently to the old waste management law and in this way implements the guidelines of the EU law. Firstly, it targets the protection of earth's natural resources whereby it promotes recycling management in Germany and ensures environmentally friendly methods of waste management. Accordingly rubbish is initially to be avoided. Secondly rubbish material is to be made use of or to be used for energy extraction (energy recovery). With material recycling, material is to be extracted from the waste, which, as secondary material, makes the use of new raw material dispensable. If the waste cannot be recycled, then energy recovery is to be considered. Underneath the umbrella of the recycling economy the legislators have enacted particular laws in which dealing with various materials is governed.

1.1.1 Packaging Regulation (VerpackV[2])

The exact meaning of legal regulations and their practical application in Germany is governed by governmental statutory regulations. One such statutory regulation is the regulation about the avoidance and recycling of packaging (Packaging Regulations – Verpack V).

On the European level, the directive on packaging waste materials was adopted in

1994, which necessitated that the national packaging regulations were to be adapted in terms of content. This EU directive was amended in 2004 and subsequently implemented into national law through the legislation.

The Packaging Regulation was developed under lead management of the former Environmental Minister, Prof. Dr. Klaus Töpfer, and was already in force very early, namely in 1991. In Germany, the energetic implementation of the recycling management concept begins with the Packaging Regulation because approximately half of all German refuse bins in households and small industrial businesses – mostly described as household waste – are used and thrown away packaging. Measured by weight they still make up about a third of household waste.

With the Packaging Regulation, both trade and industry are obliged to take back used packaging from consumers and to ensure a recycling of packaging waste. Consequently the packaging waste is treated according to six types of material (material fractions): glass, paper/cardboard/cartons, tin foil, aluminium, plastics and composite material. For each of these material fractions the Packaging Regulation defines exactly, which share of this packaging must be recycled as shown.

1.1.2 End-of-Life Vehicle Regulation (AltautoV[3])

In Germany about 2 million scrap vehicles accumulate each year. Consequently, on 1st April 1998 the End-of-Life Vehicle Regulation came into force, whereby the legislator has created general regulations for waste management in Germany.

The draft of a so-called proof of recycling documents that the end-of-life vehicle is properly recycled according to the state of technology.

In scrap yards the vehicles are dismantled on the belt, the operating materials are removed separately and collected in containers. The dismantled parts are collected for further processing in containers for plastics, glass, metal, tyres etc. Business can sell the intact parts as second-hand parts.

Dismantled parts such as synthetic bumpers, dashboards, glass, metal parts or tyres are ultimately sent to the shredding plant. Here approximately 25 weight percent of scrap vehicles are currently mechanically compressed. This applies to the non-recyclable, so-called shredding light fraction. It is currently ultimately stored in household waste depots. It is to be allocated to a public welfare disposal in accordance with the KrWAbfG. The legislator binds the automobile manufacturer to progressively reduce this share from 25 to 5 per cent by 2015.

1.1.3 Batteries, Electronic Scrap, Textiles

In addition, there are several legal regulations for other types of waste. The Battery Ordinance (BattV[4]) was passed for this, which has bound manufacturers and dealers since October 1998 to take back used batteries.

Since March 2005 the Electrical and Electronic Equipment Law (ElektroG[5]) has governed the recycling of cases and "inner lives" of used computers, television sets, telephones and other electrical and electronic appliances.

Regulations are being planned for other types of waste. In this way, for example, about two million tonnes of used material are to be disposed of annually in Germany – clothes as well as old

Recycling starts with the consumer

Emptying of yellow bins

[3] *http://www.bundesrecht.juris.de/altautov/index.html*

[4] *http://www.bundesrecht.juris.de/battv/index.html*

[5] *http://www.bundesrecht.juris.de/elektrog/index.html*

carpets, curtains and upholstery.

The aim of the German Environmental Policy is to reduce all waste in Germany, for example by 2020, through the economic cycle in such a way that dumping is unnecessary.

1.2 Responsibility in Recycling Management

It is obvious that the recycling management model can only operate in conjunction with everyone concerned in the businesses. Therefore there is no sole responsibility. The environment and its protection are inseparable goods for which every individual actually bears joint responsibility.

In Germany as a federal state the obligation is incumbent on the Federal legislator as well as the Federal states to create the general regulations for an effective recycling management and to monitor the implementations resulting from free-enterprise regulations. The local authorities determine their fragmented aims in line with municipal statutes. The states – and here particularly the State Environmental Ministries – but also the municipal regulatory authorities are highly responsible in the supervision and enforcement of the objectives described in the recycling management law.

In Germany the legislator has imposed the main responsibility for the success of recycling management on the product manufacturers and distributors. They should not be able to cancel this responsibility after the sales of their goods to the consumer.

The specific fulfilment of the subsequently resulting obligations is ensured in a free and social market economy at best through free-enterprise solutions. It is therefore understandable that the economy has used the option of organising individual solutions for an area-wide collection, sorting and recycling of the circulated packaging.

The consumer plays a specific role in recycling management. Since circulated products – regardless of whether they are furniture, batteries, cars or packaging – are ultimately purchased and/or used by the consumer, recycling of these products without consumer commitment is inconceivable.

The example of the collection of packaging waste established in Germany – and meanwhile across most of Europe – shows the fact that consumers are also greatly committed in meeting their responsibility without coercive measures. This already existed in the old federal states for the glass and paper fractions before the emergence of the Dual System[6]. But the concept of recycling management began its current distribution only with the area-wide introduction of the Green Dot in 1991.

Today, more than 80 weight percent of all sales packaging annually disposed as waste in Germany is collected from German households. The Green Dot on a package signalises that the packaging market with this takes part in the collection system of the Duales System Deutschland GmbH and the filler provides a financial contribution for this purpose.

1.3 Meaning of Free-Enterprise Solutions in Recycling Management

1.3.1 Internalisation of Costs

For a long time, production costs of a product have been understood to mean only the resources, which the manufacturer uses and must be paid for using money,

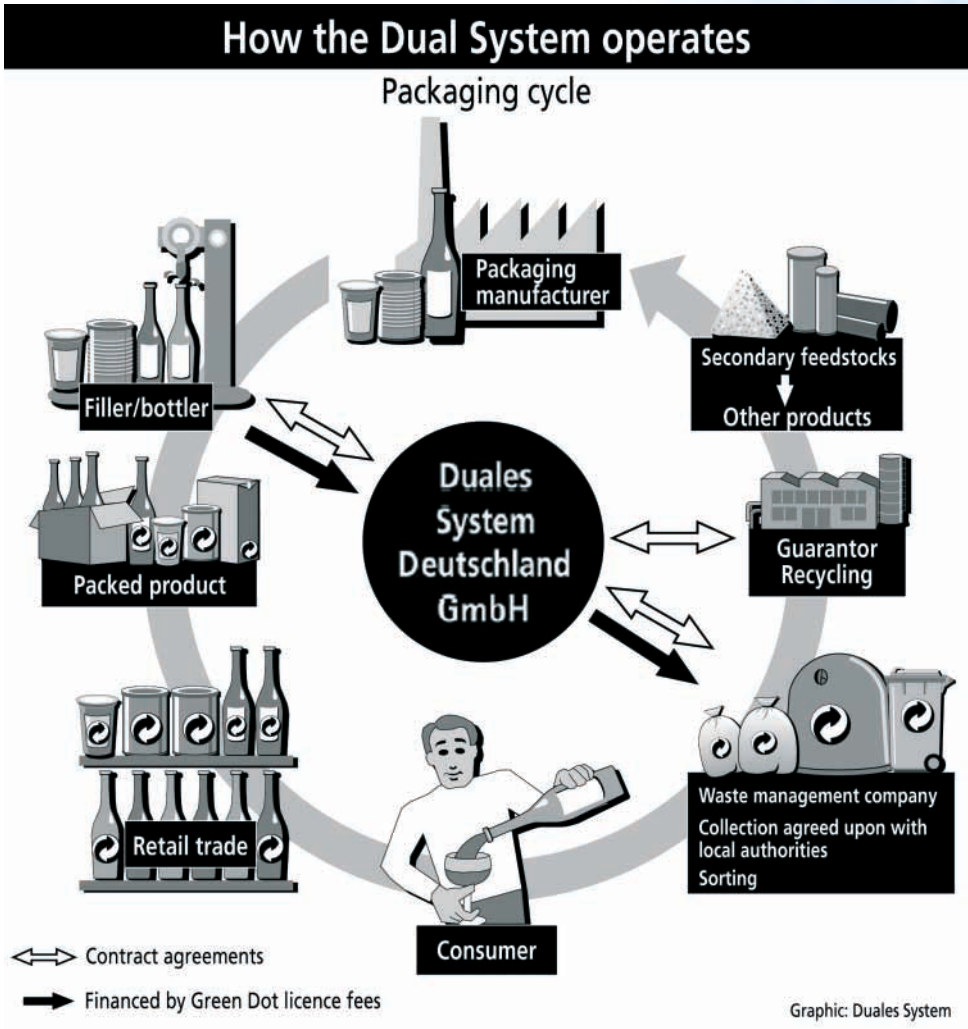
for example the production time, raw materials and the wear of machines. This perception includes just one section of the actual costs because environmental pollution, generation of noise and the production of packaging waste are indeed not immediately shown in prices and paid by the manufacturer, yet represent company costs.

These costs, which do not directly lead to expenditures for the manufacturer but instead exist for the neighbour, customer or the general public, are shown as external costs.

The assessment of these costs is sometimes directly and sometimes indirectly possible. For example, if a lake is not longer suitable for bathing due to sewage, similar to compensation for immaterial damages, how this loss can be expressed in Euros can only be estimated through a professional opinion.

Valued in Euros, the arising costs are now trying to be charged to the waste producers. For waste producers, this means that these environmental loads are costing them money. The previous "external" discharged costs are here also economically applicable to them – this effect is called cost internalisation. With this pattern change, a rethink should be initialised – up to a responsible human treatment of their environment.

The alarming waste disposal situation in the Federal Republic in the 1980s has made it necessary to undertake all efforts for the avoidance and recirculation (recycling) of waste. Waste avoidance and waste recycling therefore are transferred to the centre of efforts in order to manage the problems of waste disposal in the Federal Republic. Only this way is it hoped the problem of amounts of waste on a continuing basis can be solved and with the population the necessary acceptance for waste disposal facilities can be produced.



How Duales System Deutschland GmbH operates

[6] *http://www.gruener-punkt.de/*

1.3.2 Optimisation of Products and Packaging

Optimisation actually means the achievement of the best overall possible condition. Therefore products and packaging are regarded as a unit.

The ideal condition in relation to packaging would be a free perfect protec-

Optimised glue-stick packaging

[7] *http://www.ara.at/*

NIR technique aggregate

NIR technique aggregate

tion of goods with good appearance, without weight and without any arrears, after the product is used. Of course, this is not achievable.

For the manufacturer, optimisation means to produce as cheaply as possible while adhering to these general conditions. If here only the pure production costs had to be taken into consideration as before, this would lead to only the cheapest solutions being used – even if this causes considerable environmental loads. The product and packaging optimisation today however goes much further. Weight optimisation, transport optimisation and material saving are just a few factors, which contribute to an overall optimisation.

The manufacturer will often determine that environmentally friendly products and packaging then also become cheaper for him if the direct production costs are initially higher.

1.3.3 Efficient Secondary Raw Material Extraction

Secondary raw materials are understood to mean materials, which cannot directly be extracted through mining or farming but instead through the reuse or recycling of already used materials. For example, remnants and old rags have been processed into paper for centuries and also waste paper can be used to manufacture paper and cardboard.

The use of materials for the production of new goods or packaging is however often only limited. For hygienic reasons, food packaging for example must generally not be produced from recycled plastics. New technology however is increasingly allowing secondary raw materials to be treated in such a way that the material, for example PET, can be used in the production of new packaging – the material can be used both as an intermediate layer in a multilayer packaging as well as an inner layer (therefore with direct contact to food).

Where recycling is possible, it only becomes attractive to manufacturers of course, if it is not essentially more expensive with all costs for collection, sorting, separating, cleaning and the further processing than production using freshly extracted raw materials.

1.4 Recycling Management at EU Level

Many EU countries now have recycling management systems to recycle waste. In Austria, for instance, the ARA AG[7] (Altstoff—Recycling Austria) deals with the recycling of glass, paper and other packaging analogous to the Dual System in Germany. In other countries such as Belgium, France, Greece, Ireland, Latvia, Luxembourg, Norway, Austria, Poland, Portugal or Sweden, Czech Republic or Hungary packaging is also collected and recycled under the Green Dot marker. Meanwhile, the Green Dot has become the most used trademark in the world.

2 Sorting

2.1 Sorting Lightweight Packaging

In Germany, used lightweight packaging LVP (plastic packaging, metal, composite material, which stem from private household) has for a long time been collected separately as a component of household waste and subjected to recycling. They are separated into about five to ten different fractions in sorting plants developed specifically for this purpose.

The annual treatment capacity of LVP sorting facilities is mostly at approximately 10,000 to 20,000 tonnes. Large facilities have capacities of up to 85,000 tonnes per year. They sort the packaging waste of about 3 million people in heavily populated regions.

2.1.1 Technology

Depending on the collection system for the lightweight packaging, the sorting is added to an opening and emptying of containers, which can simultaneously be coupled with an extraction of rough anionic waste. Subsequently the material is sent via a delivery volume on the main sorting section.

At the beginning of the main sorting, the Duales System Deutschland waste filters through a sieve by using a sieving drum or vibration sieve in most facilities. Here the waste is classified according to different sizes and fine components such as organisms and dust (e.g. sweepings) are sieved (sieving classification).

Then lightweight materials using air separator/fans, ferrous metals using magnets and non-ferrous metals such as aluminium using eddy current sheaths are separated.

In modern sorting facilities at least two, generally however three or four near infrared detectors (so-called NIR units) combined with other sorting units are installed. For separation of plastics coated (drink)cartons and composite plastics two of these sorting units are regularly used. A third NIR unit frequently serves to separate the paper/cardboard/boxes fraction, which is not a part of lightweight packaging.

Also sorting according to types of plastic (PE, PP, PS etc.), a requirement for high-quality recycling, is today possible using NIR units. Efficient machines today extensively replace the earlier conventionally complex sorting by hand. In many facilities, reducing and pressing are added for the packaging of separated material flows.

3 Material and Energy Recycling

3.1 Processes

3.1.1 Material Process (basic and raw materials)

With material recycling (recycling), the material itself is preserved, however is transferred into another form. In this way old glass is remade into new glass, waste paper again into paper or cardboard. This is called basic material recycling: the waste becomes basic material in order to produce new materials from it. With raw material recycling the waste is changed back to its raw material, for instance plastics into petroleum. This raw material can then be used differently.

3.1.2 Energy Processes

With energy recycling the waste is not materially preserved, only the energy is used, which is released with the burning of the material. Compared to simple waste burning it however does not mean to simply remove waste but instead intelligently use the incidental energy from burning. The burned waste replaces other fuels and consequently contributes to the protection of resources.

3.2 Recycling of Packaging in Germany[8]

3.2.1 Paper, Cardboard, Cartons

Waste paper recycling is one of the

Sieving drum in action

Air separator in action

Mode of action of an eddy-current separator (Illustration with friendly permission from Master Magnets Ltd.)

[8] *http://www.gruener-punkt.de/Was_wird_woraus_.56+B6Jkw9.0.html*

Glass packaging (picture reproduced by kind permission of Aktionsforum Glasverpackung)

Aluminium from the pyrolosis plant

Film products are extracted from film blowing plant

longest applied recycling processes. The collected waste paper is dissolved in water to a pulp. Subsequently impurities such as paper clips or sellotape must still be removed. For packing paper, the pulp can immediately be made on the corresponding machines into new paper. If newspaper paper is indeed to be made, the old printing ink must still initially be removed. This is done using water, sodium hydroxide and soap. Waste paper in Germany today is the most important raw material for the production of paper.

3.2.2 Glass

Glass is extremely well suited for recycling. Regardless of how often glass is remelted and reformed, the quality always remains the same. A prerequisite is indeed that the collected raw material is separated into colours. The colour-sorted glass is reduced, then the cullets run through various sorting aggregates - the rest from seals and lightweight paper and plastic parts from labels or sleeves are whirled up and extracted. Now the shards are sieved and once again exactly sorted in order to remove even the smallest remains of wrong colours or impurities. In the melting tanks the glass shards are liquefied at 1200°C to 1500°C, subsequently new glass containers can be formed from it.

3.2.3 Tin Foil

Similar to glass, tin foil can be recycled limitlessly. Using magnets, it can simply be sorted out from the remaining packaging material. To save space, the tin foil is then pressed into parcels in junk presses, which can then be melted down in the steelworks. Through recycling scrap tin foil, 1.5 tonnes ore and 665 kg carbon is saved per tonne of used material.

3.2.4 Aluminium

To recycle 20 tonnes of aluminium from scrap requires the same energy as the production of a single tonne of aluminium from the raw material bauxite, and indeed without that the quality of the goods suffers. Aluminium from our waste has either the shape of thin film (aluminium foil, bags from snacks etc.) or thick-walled containers such as drinks cans and meal trays. Some of these packages are also coated with plastic. To preserve the pure aluminium, the reduced material initially goes through a heating treatment (pyrolisis) where impurities are separated.
The result is a pure aluminium resin, which can now be remelted and processed.

3.2.5 Plastics

Essentially with plastic recycling there are three options: basic material recycling, raw material recycling and energy recycling.

With basic material recycling the plastic is reduced and then separated based on its thickness in the different materials. Polyethylene or polypropylene, polyvinyl chloride or polystyrol are examples of different plastics. These genuine plastics are melted and processed into resin, which the plastics industry uses as raw material. A third of plastic packaging is suitable to be recycled this way.

PET (polyethylene terephtalate) assumes a special position here. As a result of its marginal weight and its high shatterproof security, it plays an increasingly important role in the packaging field — especially with regard to beverage packages. PET is separated from other plastics by means of NIR technique and separated into clean and coloured PET in purities of over 95 percent. High-purity recycled materials which can be utilised again for

the production of beverage bottles are able to be extracted via a special process from the used, colourless PET bottles. The PET bottles are first ground, washed and freed from labels. The material's surface – and also deep-seated impurities – comes off through further mechanical and chemical cleaning processes. In the end, the grinding material is again suitable for the production of foodstuff packaging. The direct production cycle of PET bottles is completed for the first time as a result. For instance, the coloured PET bottles are utilised for production of textile fibres from which fleece pullovers, sleeping bags, insulation materials or foils are manufactured.

Raw material recycling then changes the plastics back into what it originally was – oils and gases. The plastic parts are reduced and cleaned, subsequently they are heated under pressure and shaped into small beads. This so-called "agglomerate" can for example be used in the production of pig iron – here the agglomerate replaces the otherwise necessary heavy oil in the reduction process of iron ore to pig iron.

The trend – particularly with fragmented, polluted and heavily mixed plastics – however always tends more towards energy recycling. Therefore plastic is no longer recycled materially. The high energy contents released in the burning process is used. This opens an alternative for energy attainment from fossil energy carriers.

3.2.6 Composite Packaging

Milk or fruit juice, but also soups, sauces and puddings are today very frequently offered in cartons, which are coated internally and externally with polyethylene and possibly also internally with aluminium. The recycling of these products is not a problem: after a machine shredding process the cartons soak in large perforated barrels. Only cold water is additionally required, no chemical additives. Through the holes the dissolved fibres of carton dissolve and they can subsequently be recycled like waste paper. The polyethylene and aluminium remains are delivered to the cement industry. Here aluminium is used as a replacement for bauxite and the polyethylene as an emission-free energy carrier (energy recycling).

3.3 Recycling of Other Bulk Products

3.3.1 Bio-Waste

Orange peel, dried bread, withered flowers, used teabags, waste from cleaning vegetables or mowed grass: everything is understood as bio-waste. Under the right conditions, bio-waste produces mould from which plants can regrow in gardens or flower pots, or bacteria, which decompose the waste material and produce biogas, a natural source of energy.

To produce compost, bio-waste is collected and impurities such as plastic bags or wires from flower bouquets are sorted out. The reduced bio-waste is then mixed with straw, bark, bush extracts or loppings in order to ensure a sufficient aeration and to prevent decomposition. In so-called compost heaps the mixture rots within 12 weeks into compost. It must be moved several times so that the process develops equally.

The creation of biogas from bio-waste represents an alternative. By excluding air, special bacteria "digest" the bio-waste and therefore produce the flammable gas methane. With this method a residue is left over, which can still be subsequently composted.

Production of recycled PET-material

Paperfibres are separated in drum pulpers

3.3.2 Batteries

In Germany about 30,000 tonnes of old batteries from different electrical and electronic appliances are accumulated each year. About 10% of this amount contain poisonous heavy metals such as lead, cadmium or mercury and must be disposed of carefully.

The heavy metals are removed using distillation processes. Steel and nickel are used in stainless steel production.
The non-poisonous "normal" household batteries (alkali-manganese or zinc-carbon batteries) represent about 90% of used batteries. Since 1998 in Germany such batteries must not contain any mercury[9]. In a few years if the old components are completely used, all "normal" batteries will then be thermally recycled.

[9] *http://bundesrecht.juris.de/battv/BJNR065800998.html*

3.3.3 Electronic Waste

Disused computers and other electronic appliances represent a problematic connection of resources and toxins. Old computers for instance also contain in addition to plastics the precious metals gold, silver and palladium as well as copper and tin. Indeed per appliance this only totals milligrammes but in the overall results however is usable amounts. In order to gain a gramme of gold, three old PC's are enough – some precious metal recycling operations have specialised in the recycling of metals from electronic scrap. From March 2006 in Germany manufacturers of electrical and electronic appliances have been obliged to take these back and to dispose of them.

3.3.4 Motor Vehicles

Based on the increasing service life of modern cars, the service life of the entire vehicle, but also the individual parts is lengthened. Compared to the majority of consumer goods, in the course of their life cars often change ownership several times.

There is a market for used parts: car manufacturers themselves keep centres in which well contained body parts are sorted according to types, years of manufacture and colours so that they can be used to repair used cars. At the time of scrapping, cars and commercial vehicles are however made up of a multitude of materials, which without separation and recycling either degrade only very slowly (plastics, but also the always better rust-protected plates) or can even be poisonous and environmentally harmful (battery acids, lubricants). With the cars built today the plastic parts are designed with codes in order to simplify sorting and recycling. Precisely this way, as must be with new models during the construction of test vehicles through the crash-test, the first vehicles are already given to waste disposal operations, therefore it can be tested how good and clean after many years at the end of the car life the degradation in the parts works.

3.3.5 Used Textiles

Clothing is often only replaced if it is damaged or worn out. But the majority of people in industrial countries already throw out clothes if they are no longer in fashion.

This worn clothing still has a long life ahead – the large aid organisations such as the German Red Cross, "Diakonisches Werk" and "Caritas" collect old clothes. They sort out wearable clothes and if required give them to those in need at home and abroad. A section of the wearable clothes goes to second-hand shops for sale and in this way pleases the new owner.

Recycling Management

In Germany, textiles, which can no longer be used, are accepted by about 300 textile-recycling plants. Here the old textiles are changed for example into cloths or some are sent for further recycling. Here the textiles are finely shredded and respun, for instance into non-woven fabrics. Synthetic material can be processed into resin for the plastics industry and shredded textiles are also used in so-called textile hardboards.

4 Future of Recycling Management

4.1 Technological Perspectives

Recovering used packages in 2005

The path to better sorting and recycling results is driven by new technology. The Duales System Deutschland GmbH in the area of packaging recycling targets constant further development and innovations. The degree of automation in the German sorting plants has constantly gained in recent years. Human sorting ability is increasingly limited to the after-supervision of the machining processes. Therefore the first fully automatic sorting and refining system for lightweight packaging was innovative and groundbreaking, which was introduced in 2000 at the EXPO 2000 in Hanover.

By using modern technology, it was possible to half sorting costs and to correspondingly lower the licensing fees for the Green Dot.

Modern sorting facilities are one example of how ecological thinking and economic treatment can be accommodated.

4.2 International Recycling Management Potentials

The economic boom of the last decades of the 20th century in the industrial countries has already left clear environmental traces behind. The greatest challenge of a sustainable development is therefore on the one hand the stabilisation of the world climate and on the other hand the limitation of the population growth. Only a responsible treatment of natural resources of the earth can prevent globally ecologic and economic crises.

A solution approach for resource protection is recycling. Here, Germany has accepted a leading role together with other countries. Also the principle of producer responsibility has in many countries been accomplished and is implemented – in different models – for the creation of sustainable economic structures.

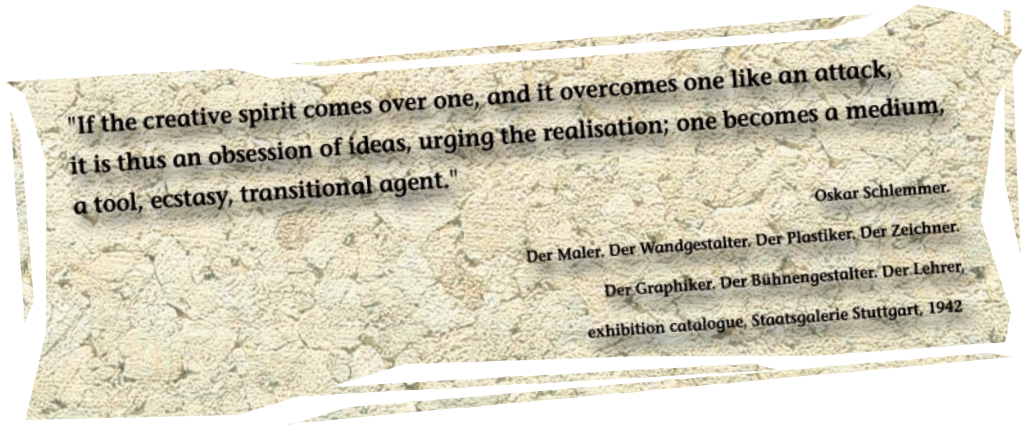
4.3 Supranational Cooperations

The precursor position of Germany in the area of recycling management has already led ideally and technically to different cooperations alongside international recognition.

The concept of a Green Dot has already been copied in many countries, which ope-

Breakpoints

As you experience this Learners' Guide you will see opportunities to take the road less travelled. Boxed like this, these breakpoints will offer mindful reflection and meditation for developing your own destination.



[10] *http://www.pro-e.org/*

rate within Europe under the name PRO EUROPE[10] (e.g. Belgium, France, Latvia, Luxembourg, Norway, Austria, Portugal, Spain, Czech Republic). Technical, organisational and logistical problems are solved across the borders. In order to spread the concept of the Green Dot, the Duales System Deutschland GmbH amongst others works together with the chambers of foreign trade and here achieves with many companies, future licensees, convincing work. Even Canada, the biggest country in the world, uses the Green Dot brand as the first non-European country.

With the development and realisation of innovative solutions for the recycling of packaging, Germany belongs to the leading nations. Here, Germany annually exports environmental protection goods in the value of about 19 billion.

4.4 Waste Avoidance

The European economy has in recent years successfully developed measures and tools in order to reduce the emergence in packaging waste and the use of natural resources.

With initiator-equitable licensing fees calculated according to material and packaging weight, the Green Dot systems in Europe have created an incentive for companies to reduce packaging quantities.

The waste avoidance was integrated in the packaging development and the product conception. Therefore packaging has become considerably lighter through material saving. Furthermore material compounds were changed and material composites simplified or replaced by mono-packaging. In addition more recyclable materials and secondary raw materials were used.

5 Sustainability requires networked thinking and action

Global environmental matters such as greenhouse effect, the decimation of biological diversity and the consumption of limited resources can only be solved on the basis of more intensive international cooperation. People with an understanding for ecological, economic and social interrelationships on a global level will be required in order to overcome these challenges. The Der Grüne Punkt – Duales System Deutschland GmbH and the European Green Dot systems will continue to be active as pacemakers with regard to the achievement of these objectives.

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Corks – People – Cranes

Recycling Cork helps People and Cranes!

by Barbara Maitin , with Kristin Ackehurst, Janina Rennholz, Janine Rudolph

Introduction

"Think globally, trade locally!" - a motto, which searches for examples, which can make every single one of us aware that apparently small insignificant actions have positive effects nationwide. Corked bottles are used in every household. The NABU Hamburg KORKampagne [cork campaign] recycles collected corks whereby they are sorted in workshops for the disabled, shredded and recycled to be used as housing insulation. This initiative has created four jobs for disabled people and supports the protection of cranes in Germany as well as in Spain. A very special and effective method of recycling!

Even with the beginning of the "UN Decade of Cultivation for Sustainable Development", the KORKampagne represents a project, which meets all sustainability criteria.

By discussing this issue in the classroom, young people get to know the conditions in very different ecosystems, which have to some extent been named biosphere reserves or World Natural Heritage sites and are linked by the cranes. These ecosystems are retreating grounds for particularly rare species, which could not survive without the protection of mankind. In addition to these endangered species, they offer a rich, typical flora and fauna habitat, whose preservation contributes to the bio-diversity. Even this can be made apparent in this example.

At the same time e.g. economic, cultural and sociological aspects can be highlighted from cork production and recycling both on the Iberian Peninsula and in Germany. These aspects also help to secure the future existence of the people in the respective regions.

Ecology of the cork oak and the properties of cork

The cork oak (Quercus suber) is part of the Fagales order, which is almost exclusively made up of anemophilous, monoecious woody plants. The order is divided into two families: the Betulaceae (birch and hazelnut) and the Fagaceae (beech), which also includes the cork oak (1).

Fig.1 Cork oak, Quercus suber (Fagaceae), with male catkins (from: Knaurs Pflanzenreich in Farben, Höhere Pfl. (1) Picture 58

The cork oak is an evergreen unlike our native oaks. Its leaves look more like holly and are essentially smaller than those of our oaks. This shows that this species has adapted to dry habitats. Yet another characteristic is to be understood as an adaptation to such habitats: the development of a particular bark, which we refer to as cork.

What is cork?

Cork cambium is a layer of cells capable of dividing, which forms the outer surface on woody plants. Through the growth in diameter this tissue is gradually cut off from the supply of nutrients and water and dies out. The cork oak is the only tree where the cork cambium never stops its activity. Year after year, the dying tissue forms layers, which protectively surround the stem.

Fig. 2 Cross-section of a cork oak stem. Cork is a natural raw material with excellent properties.

Which is the correlation between the cork formation and the habitat of the tree?

Its natural habitat is the western Mediterranean area of Southern France across the Iberian Peninsula to North Africa. Italy is also a cultivable land of this important agricultural crop plant. Attempts to cultivate this plant in

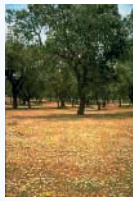

Fig. 3 Landscape aspect of the dehesas, the holm and cork oak tree populations are planted like an orchard and lopped and freed from shrubs.

climatically comparable areas outside of the Mediterranean area have failed.

The tree grows in association with the holm oak (Quercus ilex) in sparse forests, which e.g. form the natural scenery of the dehesas in Extremadura in Spain (Fig. 2 and 3). However, compared to the holm oak, the cork oak grows in places where water can be more easily obtained by the distinctive taproot.

In the growing areas, large-scale fires break out time and again during the summer drought, whereby other tree species such as pines immediately fall victim. The cork oaks withstand the fires. After a few months the tree comes into leaf again because it is still alive under the singe bark (3).

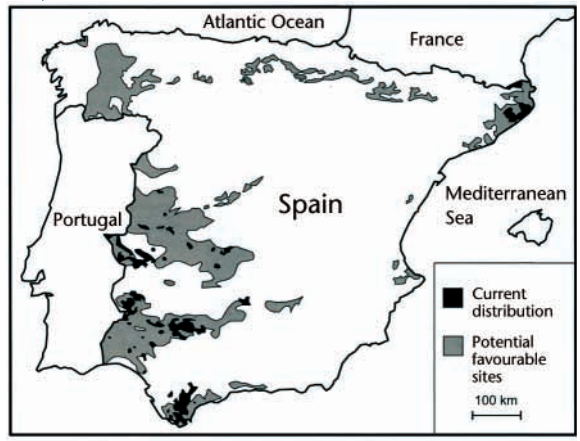

Fig.4 Distribution of cork oaks in Spain

The development of cork and its specific properties lasted millions of years:

Depending on the season, one cubic centimetre of cork is made up of about 40 to 100 million cells (the inventor of the microscope, Robert Hooke, examined bottle corks in 1665 and in doing so discovered honeycomb-shaped pores, which he called "cells"). These cells contain 90% air and only a bit of solid material. The attribute of exchanging air using very fine pores is crucially important with the majority of areas of use.

The solid cork material essentially contains the following material groups:

- 45 % suberin (cork), which is responsible for elasticity,
- 27 % lignin (wood), which ensures stability, 12 % cellulose and half cellulose
- 6 % tannin (tanning agent), which amongst others prevents rotting
- 5 % keroid; impermeability of the cork depends on this
- 5 % minerals, water, glycerine amongst others

The physical properties can be explained through the cellular design and chemical components:

- very light, it has a volume weight of 100 to 250 kg/m^3
- impermeable to liquids
- compressible and elastic
- poor heat conductor (thermal conductivity amounts to 0.040 – 0.055 W/mK)
- resistant to deterioration
- excellent heat, noise and vibration insulator
- flame retardant, good chemical inertia, not putrescent
- compresses without expanding to the sides (4)

Production of cork and its economic significance

History, cultivation and cork extraction

We know that the Egyptians used pieces of cork as floats for their fishing nets in 4500 BC. Between 400 and 300 BC, the

Corks – People – Cranes

Greeks introduced cork oak as an agricultural crop plant. The first references appear around 70 BC that the Romans found the cylindrical pieces of cork were suitable as stoppers for vessels. In the 2nd century AD the Romans took this knowledge along to the Iberian Peninsula, the then Roman province, Hispania. With the beginning of glass production in the 17th century, the importance of the cork industry increased enormously with this new market.

Today Portugal has taken over as the market leader with an overall production of over 50%. Almost a third of the entire landmass is covered with cork oaks. Approximately 25,000 people are employed in the cork industry in Portugal (4).

A young tree needs about 25 – 30 years before the first bark, the so-called virgin cork, is carefully removed from the stem without damaging the living tissue. Harvest is in the summer. In the beginning the naked stem is pink, then material in the fresh bark is oxidised and it becomes dark brown and forms a new smoother layer of cork. Only after the second or third peeling, which may only be carried out every 9 years, does the cork reach its full quality (5).

Cork farmers must think in the long-term because they must wait at least 38 years until a tree yields anything that can be marketed. They work for their grandchildren and many generations thereafter. The trees can produce cork for up to 200 years and may only be felled once they are dead.

Peeling cork oaks is an art. Special tools have been developed to simplify this hard work. An experienced worker can collect up to 600 kg of cork a day (6). The year of the harvest is painted on the tree (3), so it can be seen when this tree may be peeled again. The tree rings easily show if the rest years have been adhered to.

The cork barks are delivered directly to further processing industries. There they are stored for several months in the open, so that the wind, sun and rain stabilise the texture. Afterwards the curved plates are boiled until superficial impurities or insects have been removed. At the same time, this makes the honeycomb structure of the cork cells more even and the curving of the plate disappears so that it can be better processed. After a period of maturation in the dark of several days, the raw material is sorted by quality (3). Bark with a calibre of approx. 5 cm and more – as the thickness of the cork plate is identified – is suitable to be made into bottle corks. Thinner bark is made into cork wheels, veneers, champagne corks etc.

Fig.5 Cork plates before and after boiling

The cork plates are cut into strips according to the desired length of the cork stopper. The diameter of the corks then corresponds to the calibre of the plate. The cork cutter must pay attention to cut out as many perfect corks as possible from the strips. This work requires a lot of skill so previously it could not be taken over completely by machines. The rest of the bored blanks are not wasted, but are used as a starting material for floor coverings etc.

Only about 10% to max. 30% of the overall raw production is used for the manufacture of cork stoppers. However at approx. 40%, they represent the main part of the industrial production. For the manufacture of 20 – 30 kg cork stoppers, 100 kg of raw cork, therefore the harvest of one tree, are required. Only in Portugal the individual amount per tree up to 150 kg is achieved, which in other countries corresponds to an average yield per hectare (4).

Fig. 6

These yields can be achieved without fertilising the growing areas.

The further processing of cork stoppers occurs both in Spain and Portugal and in the vicinity of the vineyard regions in other countries. The competition of the companies in the cork industry in the different countries led, on the one hand, to an increase in the quality and manufacture of the end product, yet at the same time reduced the number of factories and jobs through automation of the process.

In Germany, for example, there is just one manufacturer of natural wine corks in Trier. With 30 employees, one shift produces 700,000 corks and as a result an annual turnover of 10 million is achieved, 40% of which comes from exports.

The delivered raw corks are washed in hydrogen peroxide and consequently bleached, as a preparation for the imprint of the characteristic stamp of the vineyard.

Treatment with hydrogen peroxide also serves to completely disinfect the corks, which was earlier done using chlorine. In the chlorine treatment, chlorinated compounds emerge from the lignin of the cork, including 2,4,6 – trichlorophenol, which are converted in storage by microbial processes into 2,4,6 – trichloroanisole, TCA for short and which can cause the cork taste. Depending on white or red wine, TCA can already be smelt from 10 or 50 microgrammes per litre (8). Despite all efforts, it will certainly still take a while until all causes of the cork taste have been ascertained.

Considering the production chain from the cork oak culture across the harvest, processing and research up to the serviceable cork stoppers, the price for the highest calibre and best quality cork seems at 0.56 Euro plus VAT almost too cheap.

The importance of the cork oak forests for humans taking Extremadura as an example

Extremadura means “extremely harsh”. This description clarifies not just the unfavourable atmospheric conditions in this part of the country, but also the fact that even today, the Extremadura is one of the poorest regions of Spain. 1,073,050 inhabitants live in almost 42,000 km^2, which amounts to a population density of 25 inhabitants per km^2. 57% of the population lives in municipalities with less than 10,000 inhabitants (12).

The dehesas are an exceptional natural scenery, which emerged because humans and nature live together. It spans the south of Tajo on a dry, wide level.

Here spacious, extensive agriculture is operated. Unused areas provide a habitat and nutrition for a varied range of species. The people in this area mainly live off extensive pasture farming with Merino sheep, Retinto cattle, other domestic farm animals and pigs (9). Therefore the cork oak forests provide essentially more people with a living than just those employed in the cork industry. Cheese is produced. Apiaries play a role. Berries and fruit, which grow there, are used in the manufacture of other local products. Charcoal burners provide the population with charcoal from the cut of the cork and holm oaks (6).

Particularly in autumn and winter, the Black Iberian pigs graze in the dehesas when the nutritious acorns fall from the trees. Since cork oak acorns ripen later than those of holm oaks (11), the grazing period can be extended across winter. The feed makes the special taste of the ham

and is so rich that the pigs put on up to one kilogramme a day in weight. Birds feed on the acorns without competing with the pigs. This also makes the dehesas so attractive for the cranes as wintering grounds.

Agriculture is carried out in clearly defined areas. In the spring, the livestock can graze on the harvested fields. They lie idle for a few years and the cattle provide natural fertilisation of these areas. After a few years the fields can then be used again for cultivation.

In the hot, dry summers, the most misanthropic season in the Extremadura, the shade of the trees offers people, plants and animals protection from the sun. The foliage, which results from the cut of the trees, serves as feed in the scare times, whereby the dehesas with a cork oak population are in a better state of care than the forests, in which only holm oaks grow.

By adjusting to the climatic conditions and the variety of species of the landscape, forestry has developed, which in comparison to other European forest regions can thus be used by many industries and can offer people a livelihood. However, the land tenures are very different. 91% of the dehesas are privately owned.

Integration between cork oak owners and processing industries is rare (11). For the harvest period in July/August, the owner employs specialist workers for the peeling.

In the 1960's, e.g. the swine fever, flooding and an increase in labour costs, the competition of plastic and screw caps to cork, led to a destabilisation of the dehesas and the cork industry.

Without the demand for cork, the forests lose their economic value. It was attempted to counteract the price decline by increasing the cork harvests (8). This led to the reduction in the quality of cork and overuse of the trees. At the same time, not enough was done for the regeneration of the dehesas with new plantations.

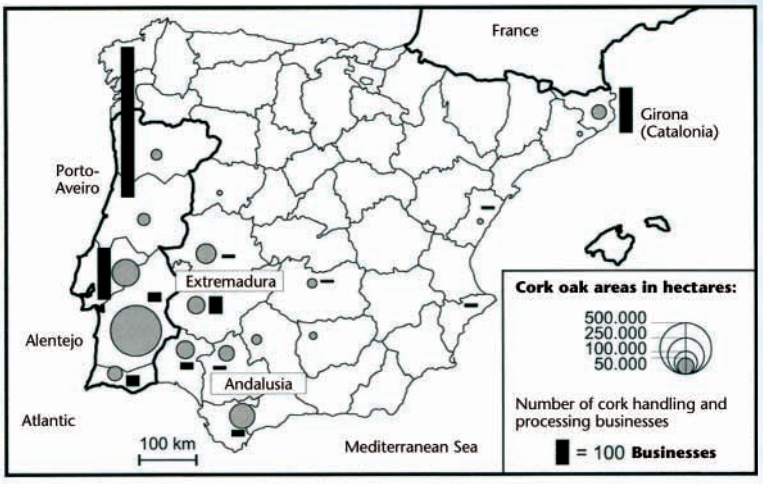

Fig. 7

On the contrary, in the search for alternatives for income, better areas, protected by the EU promotion (6), were transformed in agricultural areas, unfavourable habitats were replanted with quick-growing tree species such as pines and eucalyptus trees or simply sold for building projects in the context with the "Plan Badajoz" (9). As a result, the wooded areas were reduced by 10% in the period from 1957 to 1984 and approx. 8 million holm oaks were uprooted (13).

The agriculturally intensive, mono-culturally used areas must be artificially watered. The plantations with non-native groves absorb too much water from the ground, they offer no protection against erosion and increase the risk of fire. This restructuring was not oriented towards the principles of sustainability so that these projects

Fig. 8

Fig. 9 Grazing cranes

Fig. 10 Roosting cranes

lose in profitability. Even though the "Plan Badajoz" made the irrigation of the fields in the summer months possible by the construction of large dams, which also supplied electricity to the most remote villages, and promoted the infrastructure for industrial settlement through the road and railway constructions, no lasting success has been achieved. Until today, the promised land allocation as seen by farmers is insufficient (9). This explains also the younger generation leaving the villages in order to find work in the industries in the cities.

Through the increasing demand for country-typical quality products such as ham and cork as well as the support of the EU cohesion funds, a turnaround seems possible. Additionally, there is also the discovery of this region for tourism with its impressive World Heritage sites and natural beauty of the landscape, but especially the dehesas.

Ecology of cranes and the importance of the dehesas as a wintering ground

For some years, the people in the Extremadura celebrate the DAY OF THE CRANE at the start of December in four greeting sites in the wintering grounds where they await the arrival of the large migratory birds. Whoever has been able to experience the approach of the "trumpeting" cranes, knows what impressive natural spectacle is offered here!

This "celebration" is organised by the nature conservation organisation ADENEX, whereby this event makes this beautiful species of bird accessible to the people, understanding for their way of life is promoted and the conservation problems are made apparent (13).

Approximately 50,000 cranes stay in the dehesas and on the Extremadura fields in the months from the end of October to the start of March depending on weather conditions. As a result, the main wintering ground of the crane population from Sweden, Norway, Finland, Russia, the Baltic States, Poland and Germany lies in this region.

For this reason, the grounds in the Extremadura have a special significance for the conservation of the species.

From time immemorial, the cranes have spent every winter here. They feed on the ample acorn harvest but also on other fruits or tubers and invertebrates.

At night they seek protection on the banks of the rivers or reservoirs, by day they graze in fields or in the dehesas. While doing so, the birds mostly stay together socially. This behaviour reduces the effort in ensuring safety and offers the less experienced young birds protection when feeding. Studies have revealed that the birds eat approx. 27% of all fallen acorns, whose hard shells they can open with their beak. The share of food on the grounds broken up from grazing fields to acres amounts to approx. 70%.

The nourishing acorns contribute amongst others to ensuring that the cranes can amass enough energy reserves, which they need for their approx. 2000 to possibly 6000 km long journey back to the breeding grounds.

Corks – People – Cranes

Even today nobody knows how they recognise the change of the general weather conditions in spring and autumn. Possibly, the birds register the warm or cold upper airflows through so-called "atmospherics", a long-wave atmospheric impulse radiation, whereby they recognise the ideal departure time (14). Migration takes places in stages depending on weather conditions along set routes (Fig.11). The orientation principle relies on a "map-compass system". The young birds learn the markers in the landscape from their parents on the first migration to the wintering ground and in this way is passed on from generation to generation. The young birds' acquired knowledge is already effective on the first journey back. In Spain, the birds begin to leave at the end of January and by the start of March the last groups of cranes are mainly made up of young birds from the Scandinavian populations.

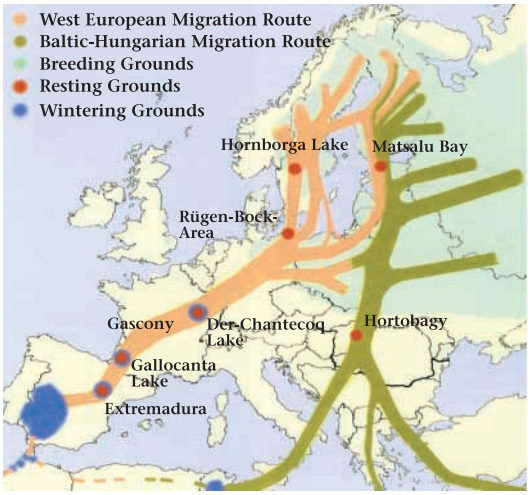

Fig.11 Habitat of the European cranes considering migration routes and resting places

A short configuration of the "master-strokes" (14) shows how impressive the migration patterns of the cranes are:

- The flight formation and flight directions change, in V-formation or diagonally, to reduce wind resistance, or in wavy lines depending on the wind conditions.
- The birds communicate in the flock through sound. The young birds consequently stand out with their chirping contact calls.
- Altitude is between 50 and 2500 metres. Maximum altitudes were recorded over the Pyrenees at 4000 metres.
- Cranes mostly soar and therefore achieve a speed of 45 – 65 km/h. Flying speeds up to 130 km/h have already been recorded over land.
- The endurance is particularly impressive. For example, in November 1986, a departure of approx. 20,000 birds was observed between 8am and 1pm. The following day, 5000 to 6000 cranes reached the Pyrenees after a flight time of 24 hours and a stretch of 1200 km.

There are traditionally long-term and short-term resting places. They are the "stepping stones", which simplify the journey back to the breeding ground for the cranes. In Fig. 11 the sites are marked where the cranes relatively regularly, after or before overcoming an obstacle such as the Pyrenees or the Baltic Sea, stay for several weeks.

Arriving at their breeding grounds, the groups dissolve and the cranes become individuals. The mating pairs, who are together for life, occupy their territories of about 1 to 5 hectares wide, preferred in alluvial forests.

However, before they build a nest in the middle of their territory, the cranes perform their impressive mating dance on neighbouring free areas, honking loudly. This extraordinary behaviour can be seen

Fig. 12

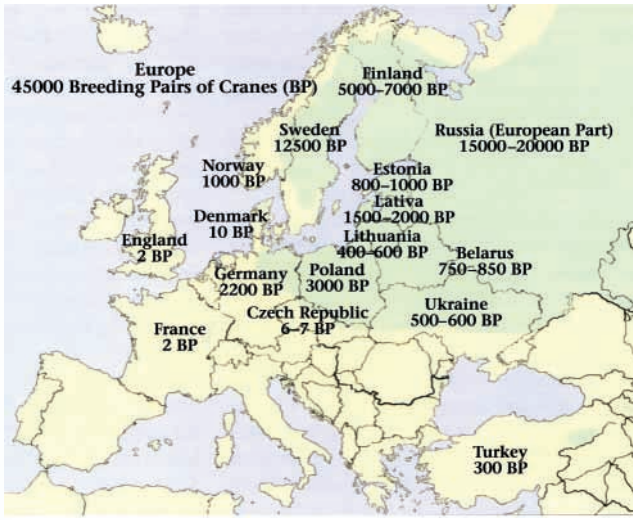

Fig.13

Fig.14

not just in the mating season, but then particularly often and fiercely.

The cranes are ground breeders and lay their nest on rising ground, which is surrounded by water up to 60 cm deep. Since the crane is at this time particularly timid and sensitive to disturbances, the nest is built as free as possible for better monitoring.

As can be seen in Fig. 13, cranes generally lay two eggs. The partners take turns in breeding. From the laying of the egg to the emergence of the first hatchling it takes about 30 days. The hatchlings are precocial birds, which, already after 24 hours, begin to explore the nest.

The hatchlings learn to fly after 10 weeks. In this time the parents use animal nutrition as fodder so that the high protein and mineral requirements of the small cranes can be covered. Later the family hunts for food together in feeding territories, which are further away. In the evenings, they return to the nest.

From August, cranes of all ages gather in quiet sites where, within a radius of up to 10 km, they find both sufficient nutrition and suitable roosting space. Depending on weather conditions the autumn migration to the Extremadura then begins in October.

The KORKampagne [Cork Campaign]

30 years ago the crane was almost extinct in Germany. In 1972, only 16 mating pairs could be counted in Schleswig-Holstein. Since then their population has increased to 635 mating pairs (as at 2005) (19).

Through systematic monitoring in Germany since the mid 1970's, the following development reveals itself with the passing number of cranes from the Western Europe route:

In 1980 there were 40,000 birds, by 1990 already 70,000 and again 10 years later 100,000 cranes. If the measurements are combined on the middle and western migration route, then almost 200,000 cranes migrate to the wintering grounds (20).

Besides the adaptability of the crane, this increase in population is indeed particularly thanks to the commitment and teamwork of nature conservation and national organisations.

One example is the alliance of Naturschutzbund Deutschland [Nature Conservation Association Germany] and the environment foundation WWF – Deutschland, in which crane protectors from East and West Germany, following reunification in 1990, merged into the joint venture Kranichschutz Deutschland [crane protection Germany] and are financially supported by the German Lufthansa AG (16). In line with this project, former wetlands were bought up and renatured with the aim of creating bit by bit an expanse of habitat networks with "stepping stones".

The protection and conservation of the habitats alone is not sufficient to protect the crane population. There are more and more reports of poachers stealing eggs or

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birds being killed in the waterfowl hunt (20). Nature conservationists depend on public support to prevent such offences.

All this cannot be realised without intense marketing.

How difficult it is to create understanding for the nature conservation measures with concerned groups of people, is shown by the farmer's protest (Fig. 15) in the Extremadura at a European crane protection conference, which was called by ADENEX in 1994. The farmers feared that the construction of irrigation canals to their areas would be stopped because they ran through the cranes' wintering ground.

Since then, both in the Extremadura and in Germany, something like a "Crane Tourism" has developed, which creates new jobs in the regions and can contribute to a better environmental understanding in an ecologically compatible way for.

If the crane is protected with its habitat, then many other endangered animals and plants will be supported and preserved through these measures; in the Extremadura particularly the Iberian Lynx, the Black Vulture, the Black Stork, the Little Bustard and many more.

The successes in Germany could not have been achieved if reasonable measures were not also taken in the other countries where the crane lives or winters.

Crucial impulses for international cooperation were given by various conventions. Here the following can be named as important resolutions (21):

A simple solution is offered to us by

"Die KORKampagne" was set up in 1994. The action by NABU Hamburg and the Hamburg Nord District Office for the establishment cork-collecting places is a success story.

The aims of this project are (21):

- "Environmental protection: to protect cork from being lost as a waste product and to use it as insulation material in ecological house construction.
- Create jobs for the disabled and long-term unemployed
- Financially support the conservation of nature and promote through awareness training (in schools).

Altogether since 1994, the project has collected far above 250 tonnes corks (which corresponds to about 2500 m^3 or approx. 60 million corks) and passed them on to be processed in non-commercial establishments".

All in all, in this way, already over 30,000 Euro has been poured into crane protection projects, which has been split equally between the nature conservation organisation SEO/BirdLife and the NABU Hamburg for the protection of cranes in the Extremadura or for the breeding grounds on the Elbe.

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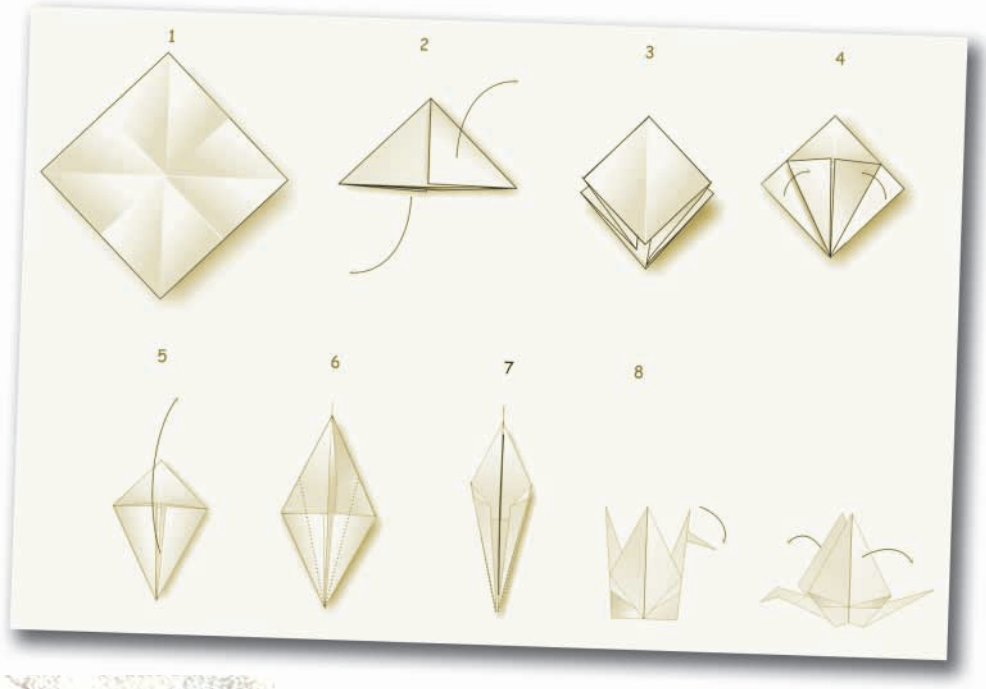
Fig.15



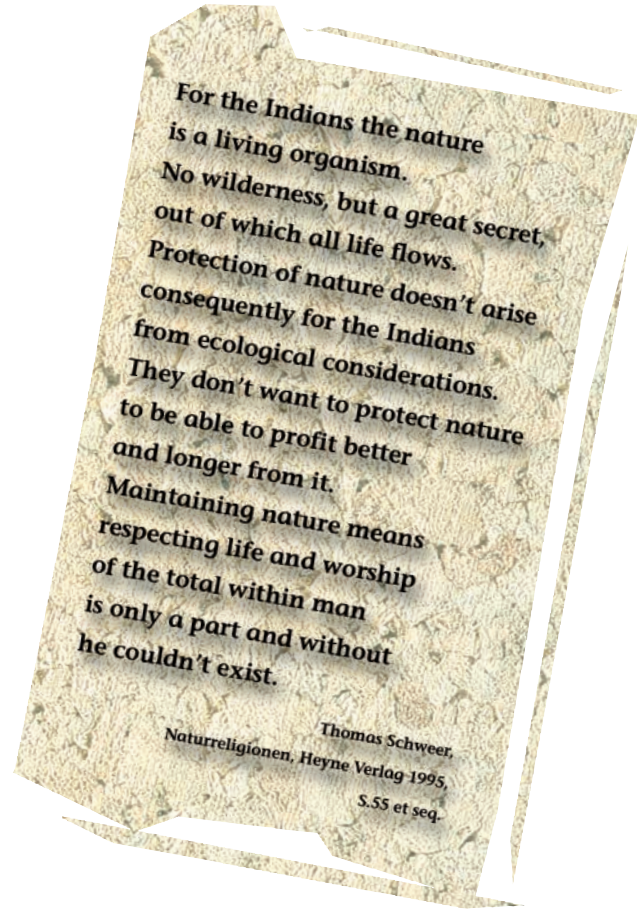
How to fold a paper crane

Folding a paper crane is a bit of a challenge – not easy for everyone, but it works! Make a competition out of it: Who of you will be the first one to have a paper crane?

1.+2. Take a square piece of paper and fold it as shown in pictures 1 and 2.
3. Bring the corners together as shown in picture 3.
4. Fold two corners to the middle.
5.-8. Continue as shown in the pictures. It is not easy, but it is possible!

If you know another way to create a paper crane, we'll be happy to find your way in our mailbox! Please write to papercrane.lg7@b-s-p.org.

On the BSP Learners' Guide 7 website:
More about cranes and paper cranes
http://www.b-s-p.org/lg7/cranes



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21 Statusbericht der KORKampagne, Hamburg, 01.05.2005

List of Illustrations:

Fig. 1 Knaurs Pflanzenreich in Farben, Höhere Pfl. (1) picture 58
Fig. 2 http://www.immersperger.de/korkfachhandel/kork/wissenswertes.html
Fig. 3 http://www.immersperger.de/korkfachhandel/kork/wissenswertes.html
Fig. 4, 6 Geographische Rundschau, 55 (2003) Volume 10, p. 57, 58
Fig. 5 http://www.immersperger.de/korkfachhandel/kork/wissenswertes.html
Fig. 7 http://www.immersperger.de/korkfachhandel/kork/wissenswertes.html
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Fig. 9, 10 http://www.adenex.org/aleman/grullas98_al.html
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Fig. 13 Carl-Albrecht v. Treuenfels, Kraniche – Vögel des Glücks, Hamburg 1998, p. 110, 81
Fig. 15 Hartwig Prange, Der Graue Kranich, Wittenberg Lutherstadt, 1989, p. 24,

Paper crane illustrations by Peter Runge, Glücksburg, peter.runge@b-s-p.org

Life Cycle Analysis

by Susanne Mellvig and Lars Davidson

Life cycle analysis: raw material – production – transport – consumption – refuse

For a number of years we have made our students do a computer supported project as part of the environmental science in biology. They make a life cycle analysis of a consumer product.

They work in groups of four during a four to six week period and are given fifteen to twenty hours to complete their report. Parallel to this project they are given five lectures addressing the major environmental hazards. They work in computer classrooms and it is understood that all work is done while they are at school.

Life cycle analysis (LCA) is a tool that can be used in order to make complete environmental judgements of products - "from the cradle to the grave". The use or the final treatment of the product in the refuse stage can cause much greater environmental damage than the actual production. Sometimes the transport or the extraction of the raw material is the stage that is most harmful to the environment.

Responsibility both from the producers and from the consumers is important if we want to make changes on the environmental field. The consumers are a powerful factor. For example, faced with a Swedish consumers boycott, although the producers claimed that it was impossible, diapers and other paper products bleached with chlorine quickly were replaced with products bleached with alternative methods. Our eating habits are another important factor. A person of 70 kg needs to eat about 22 kg proteins per year, but in Sweden the average consumption of protein per year is 32 kg (22.9 kg animal protein and 9.1 kg vegetable protein). Protein contains 16 % nitrogen. In theory we eat about 40 % more protein than we need. This means that we can actually help protecting the environment from nitrogen by changing our eating habits.

With this task we want to make the students aware of what they are eating, where the product comes from, how it is produced, how it is transported and that we need to find other ways of producing that are less harmful to the environment. Sometimes the students get so involved in this project that they even visit shops, asking them to stock ecological products of the same price as the non-ecological alternative. The students also need to be aware of the fact that not only the long transports (boat transport, flight) are a threat to the environment, but also the heating for example of hothouses. From an environmental point of view it could be better to buy tomatoes from the Canary Islands than from Sweden where they have been grown in hothouses. To find that out the students have to compare the energy demands for growing tomatoes and transporting them to Sweden with the energy demands growing tomatoes in Swedish hothouses.

During this project period each project group has its own folder on the school server. Only the group members and the teacher have access to the folder. The instructions are that everything that the group writes should be on the server in the group's folder, also the documents, they use pictures and statistics and other items of interest for the subject are placed there. In this way the teacher has

Life Cycle Analysis

the possibility to follow the progress of the work and – of course – the teacher has the possibility to comment directly into the group's folder. The computer system also has direct IT-links and the students often use email to contact experts and institutions.

All this gives the teacher a very important role. Not only is he/she the person responsible for the settings, the rules and the instructions but also a contact to the school computer service system (technical items do not always work the way you want). It is also very important to see to it that the groups get started quickly every lesson, that they start every session with organising their work and finish with preparing for the next session.

In the end it is time to evaluate the result and then the teacher has both the project report and the contents of the folder to evaluate the process as well as the result.

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Illustration: Natalia Chuvashova, Nacka Gymnasium, Nacka, Sweden

Handout to "Life Cycle Analysis"

by Susanne Mellvig, Lars Davidson

Task:
To follow a product from raw material, production, transport, consumption to waste products

You will work in groups: 3-4 persons in each group.

Subjects:

- Shrimp farming
- Nile perch
- Bananas
- Hamburgers
- Coffee
- Jeans – cotton
- Furniture made by "rain forest trees" (teak, mahogany etc.)
- Cut flowers
- Rice

Environmental aspects you should consider:

- Greenhouse effect
- Ozone layer
- Acidification
- Eutrophication
- Biomagnifications/Bioaccumulations (metals and organic components)
- Recycling – resource management
- The ecosystem – eradication of species
- Water management
- Soil erosion

Were do you find material?

- Study book – basics about the environmental problems
- Library
- Different companies and authorities – use the telephone or visit their homepage
- Newspapers
- Internet (but be critical of your sources)

Examples of internet addresses:
www.albaeco.com
www.wwf.com
www.britannica.com
http://www.snf.se/english.cfm

Shrimp farming:
http://www.ejfoundation.org/page211.html
www.miami-aquaculture.com
http://www.earthisland.org/map/index.htm

Nile Perch:
www.LVYP.org

Banana:
http://www.bananalink.org.uk/
http://www.twnside.org.sg/
http://www.fao.org/
http://www.cbea.org/
http://www.krav.se/english.asp

Life Cycle Analysis

Coffee:
http://www.ico.org/
www.coffeeresearch.org
http://www.fairtrade.org.uk/
http://www.geocities.com/rainforest/canopy/1290/
http://www.pan-uk.org/
http://www.panna.org/

Rain forest trees:
http://www.greenpeace.org/international/
http://www.ran.org/
http://www.fsc.org/en/how_fsc_works/policy_standards/princ_criteria

The structure of the report

- Deal with and describe all environmental problems that result from your product, from raw material – production – transport - consumption – to waste products. Describe these problems with statistics, diagrams and facts.
- Your work should be structured and illustrated with pictures and diagrams
- Follow up your questions at issue and have them as a red line in your work
- Your work should lead to a common discussion and conclusion
- Show the original sources in your text as footnote

The report should contain the following things:

- Title page – Title, the names of the group members, name of the school and year
- Table of contents
- Introduction
- The treatise:
  - write your work based on facts
  – think of the correct spelling and grammatical construction
  – Always consider the outline of the report.
- Discussion and conclusion of your work
- List of references:
  - the whole www-address
  – book-title with author, publishing house and year
  – newspaper articles with the name of the newsletter, number, dates and year
  – interviews with names and titles.

Good Luck!

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Recycling - Jeans
TÉRÈSE KULDKEPP
NINA BJURHOLM
ELIN ARVIUS
OLIVIA LUNDBÄCK
VT 2005

Recycling Jeans

Térèse Kuldkepp, Nina Bjurholm, Olivia Lundbäck, Elin Arvius

Introduction

Take a look around you – how many of the people you can see are wearing jeans? Pretty many, ha?!
In Sweden we buy clothes for around 30 billion Swedish crowns (4 billion Euros) every year and the total weight of the clothes, sheets and other textiles that we buy is about 15 kg per person per year. Of this about 10 kg is cotton.

The problem is that most of the people don't know anything about how the textile industry affects the environment. For example, take a look at us: before we started this project we didn't know much at all. We understood that chemicals and things were used during the process, but we didn't know which chemicals are used, in which quantity and how it affects the environment.

- Did you for example know that the textile industry is on the sixth place on the list of the world's most polluting industries?
- And did you know that there is an alternative to "regular" textile products – Ecological clothes?

We didn't!

But how can we increase this knowledge among more people and how can we enlarge the market for eco-clothes?

In Sweden we've got a comparatively small textile industry, but still we've come very far on the environment area. But if Sweden now has come so far and we still know so little, how is it then in other countries?

We make a comparison to the problems in the Baltic Sea. We were logged on to the internet conference "Agenda 21 NOW!" and realized that some people in the east European countries didn't have a clue about the situation and problems in the Baltic Sea. Why should it be different in this question? It isn't surprising then that the work for the environment is proceeding slowly when most of the people don't even know that the problems exist. But anyway people know more about the situation in the Baltic Sea than about the textile industries' effects on the environment, even though the textile industry is so much bigger and affects so many more people.

In fact – it's incredible how little you know about things that you use every day. Our hope is to give you, and many more, an understanding of the process from cotton field to finished jeans and what will happen to them afterwards.

History

The word "jeans" originally comes from Genoa [1], where sailor men in the 16th century sewed trousers of old sailcloth that was named "waist overalls".

The first one to sell jeans was the German Levi Strauss (1829-1902) that during the 1850s gold rush moved to San Francisco, America to make himself rich. He sold worker trousers made of canvas. Levi's began the true production of jeans in 1873. That's when they started to use denim as material.

Denim is a dense and strong cotton fabric that is used for jeans. The word "denim" is derived from a town in

[1] *Genoa is an Italian city in the region of Liguria, at the west coast.*

southern France named Nîmes. In French it was named "de Nîmes" that means "from Nîmes". In French you don't pronounce "e" and "s" in the name Nîmes. Therefore it is pronounced "Denim".

The zipper was invented in 1851, but it was not until 1918 that people started to use it on clothes. The most common material for buttons is plastic and metal. The metal can sometimes be chromed or nickeled. Both methods give discharges of heavy metals (nickel and chrome are both elements). Nickeliferous alloys can sometimes cause problems for people who are allergic to nickel. Some clothing firms put hard efforts in replacing nickeliferous metal details with stainless steel.

Cultivation of cotton

Background facts

Cotton belongs to the family of mallow plants and are bushes or high herbs which are 1-2 metres tall. The plants have big yellow or red flowers and capsule fruits that are as big as walnuts. The capsules contain a lot of strong and hairy seeds. When they ripen and open, the hairs gush and give the cotton a look of a snowball. The hairs can vary between 1 to 6 centimetres of length, and when they open they get the shape of a ball. The seed capsules of the flowers are in other words the real cotton. The seed hair of the capsule comes out, just like a dandelion and forms a piece of fluff (like a ball). The little ball later gets picked off the plant. Cotton demands a lot of water during the growth period, heat and then drought during the ripeness. Often the plant is cultivated for a one-year-period and the season of the cultivation from the planting till the picking takes approximately 180 days.

The producers

Cotton is cultivated in approximately 80 countries, among them there are the US, China, the former Soviet Union, India, Pakistan, Brazil, Egypt and Australia. With an annual production of a little more than 18 million tons cotton itself covers more than half of the world's need for textile fibres. For at least 60 developing countries the cotton export is a very important source of income. In Chad, for example, cotton brings 70 percent of the country's export income.

The world's biggest producers of cotton

Country	Cultivated area (1000 hectares)	Return of fibres (kg/hectare)	The total production (1000 bales*)
China	5360	731	18000
Former Soviet Union	3333	797	12200
US	3860	688	12196
India	7400	288	9800
Pakistan	2706	570	6700
Brazil	2320	293	3120

* One bale = 218 kg

Source: Rosier.

Recycling Jeans

Fight of vermin and noxious insects
The world production of natural fibres such as cotton, is big and has increased over the years. Cultivation is today carried out with large contributions of artificial manure, biocide and artificial irrigation. One cotton plant is sprayed about 25 times a year. A cotton field is sprayed with 3-7 more times more biocide than other crops such as corn, rice and wheat. In some places the poison DDT and similar chlorinated compounds are still used in spite of the fact that it is forbidden and we know how dangerous it is for the farm workers and the environment.

DID YOU KNOW THAT... Cotton takes up barely 5 percent of the world's field area, but 11 percent of all the agricultural chemicals which are sold in the world are used within the cotton cultivation. Take a look at the table below.

	Field area (million hectares)	Costs (million $)	Costs ($ per hectare)
Corn	129,1	2580	19,98
Rice	145,8	2580	17,69
Wheat	231,5	2365	10,22
Cotton	33,8	2365	69,97

The value of the annual selling of agricultural chemicals to the world's wheat-, rice-, corn- and cotton cultivations compared with the field area that the crops constitute. (Sources: Agrow and FAO Yearbook).

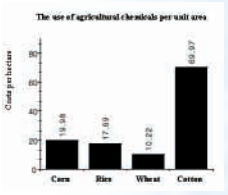
When irrigated soils have become salty, because of water evaporation, they become less fertile and the crops decrease. This is a common problem on irrigated land such as cotton fields.

The general problem about biocides is that when you have exterminated one noxious insect another one might soon replace the first. In addition insects and other vermin will get insensitive against the poisons. Therefore new pesticides must be added to bring the attacks under control.

Examples of biocides are chlorpyrifos and endosulfan. All those biocides and poisons affect the environment in many different ways in the ecological contexts through direct or indirect effects on plants, animals, micro organisms but also human beings. The poisons can cause disturbances such as reduced fertility or deteriorated seed settings.

One example: In the production of cotton in West Africa, among other things, endosulfan is used extensively to fight insects in agriculture. Many cases of poisonings have occurred in those countries, with mortal consequences. Endosulfan was introduced in the year 1956 and has been used since then. In Sweden it was prohibited in the year 1995 but not in developing countries. You can apply endosulfan in different forms, the most common way is to spray directly on the plants from the air with airplanes or with equipment adapted for the soil. In greenhouses the leading way to fight vermin is through the use of smoke tablets.

The Inspection of Chemicals classifies endosulfan as poisonous when in contact with the skin and when eaten. It is irritating for the eyes, very poisonous for micro organisms, and the substance can cause injurious effects for a long time for the water environment. Endosulfan has a distinct ability of bio accumulating, especially for marine animals. Endosulfan stays in the soil and does not leak out into the ground water. Decomposition of endosulfan is a long process in the soil and varies depending on the climate and kind of soil.

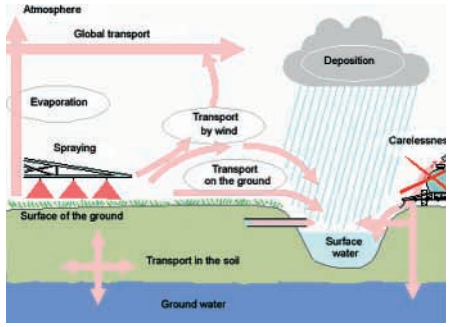


The Use of agricultural chemicals per hectare for different crops

On the map, the Aral Sea is marked with a star.

Spreading of biocides

The intention when spraying plants is that the biocide should only strike the noxious insects. Even if the technique of spraying is almost exact much of the biocide drifts away with the wind and a lot of it ends on the ground. Both through the ground and the ground water and with the wind the biocides can get a considerably bigger dispersion than was expected from the beginning. Examples of other biocides are atrazine, bentazone, cyanazine, dichlorprop, MCPA and mecoprop.



Chemical biocides were developed to increase the efficiency of agriculture production. Unfortunately biocides don't only affect insects and weeds, they also have spin-off effects on the surrounding environment and can cause health problems. The use of biocides causes reduced biological variety in the cultivation landscape. When chemical biocides are not used against weed or insects on ecological farms a better ecological variety is found there. It means more food for birds and insects of pray. The biocides are spread further in the ecosystems by water, soil, air and in the food chains and can in that way have effects a long time after being sprayed and a far way from the fields where the biocides were originally spread. Certainly the worse preparations have been replaced by ones that break down easier, but even the new ones can cause serious changes in the ecosystems. For example can marine living organisms be sensitive already at very low concentrations. If the number of individuals of one species gets reduced as a direct consequence of the exposure, other groups within the ecosystem will be influenced.

Consuming of water resources, example the Aral Sea

Cultivation of cotton demands a lot of water and more than the half of all the cotton produced is cultivated in dry areas, where when it's hot, artificial irrigation is used. Unfortunately the water resources often get overused and among others the Aral Sea, situated on the boundary between Kazakhstan and Uzbekistan, is on the point of getting dry. That because the water of the rivers flowing into that lake has been utilized to provide the big cotton plantations and rice cultivations with water. Today the area of the lake is more than 30,000 square kilometres, which is half of its original size. A lot of water evaporates from the surface of the lake every year, and the fall of rain is far from enough to compensate for evaporation. The lake's volume has reduced in size by as much as 80 percent and the water level has decreased by approximately 19 metres.

DID YOU KNOW THAT... Around 40 percent of the world's production of provisions comes from agricultures with artificial irrigation. The water consumption within the agricultural sector has increased by more than 60 percent since the year 1960.

Recycling Jeans

The cause the lake is drying up can be traced back to the sixties when the former Soviet Union started to cultivate cotton in the area. Watering systems were lead from the rivers Amu Darya and Syr Darya which flow into the Aral Sea. The environment has been destroyed because a big salt desert has formed on the former lake bottom, and this has given the consequences that plants and species have been knocked out. Poisonous biocides are spread together with the wind and injure humans and crops and also deteriorate the ground water seriously. This reduces the supplies of clean drinking water. The desiccation of the Aral Sea causes serious problems for the environment and the health of the humans. The population in the area has the highest occurrence of acute bronchi infections in the world. Biocides do not only poison water courses, they also reduce biological variety, biodiversity.

Quite an easy solution to the problems is to stop all the cultivation of cotton in the area and close the watering systems. In that way the supplies of water can get the whole way to the Aral Sea when the rivers that have been used for artificial irrigation can run out to the Aral Sea again. The big problem with this is that millions of people lose their jobs which they make their living by. It is impossible to offer hundreds of thousands of people's lives to just save a lake, but still people die as the water, that also is necessary for life, runs out.

If we don't cooperate and do something about it the Aral Sea will not longer exist and the only thing that will remain is an ecologically harmful salt desert. Fishing in the sea has been knocked out and the agriculture in the region is nearly sentenced to death. The water in the lake is 2.5 times more salty than salt water and because the salt water has a higher density it sinks to the bottom. The less salty water in the surface of the lake then gets more exposed to the sunlight and evaporates. The higher evaporation there is, the thinner the layer of fresh water becomes.

As well as the Aral Sea there are other examples, as in Texas where the supply of ground water has been halved. In other places in the US for example the use of groundwater is ten times bigger than the water that runs into the ground. We can wonder how it will end if we go on like this.

Fertilizing

Cotton plants demand high nutrient levels to give a high return, which often means use of fertilizer. The uses of fertilizer impoverishes the soil and make it useless in the long run – and also gives the consequence as overfertilization in lakes, seas and water courses. Spills of phosphorus and nitrogen happen. The bacterium balance in the soil gets disturbed and the cycle comes to nothing.

Cotton – ready for spin, weaving

When cotton has grown up, the picking of the cotton crop happens, partly by hand and partly by machines. Picking by machines is nowadays the most common and if you do it in that way the bushes first have to be defoliated. In some areas the defoliation happens naturally with the autumn frost, but the most common, unfortunately, is to use chemical defoliation means. 1 hectare of cotton field yields between 300 and 800 kilograms of cotton. After the harvest the seed capsules are dried and then separated from the fibres. That which gets left is coarse cotton that consists of approximately 95 % cellulose.

The rest is fat, resin and also a little protein and colouring agent. The cotton then gets cleaned from leaves and rubbish and the remaining seeds are separated from the piece of cotton wool in a cotton cleaning station. The seeds are pressed afterwards to extract oil that is used in food and silage. The clean cotton is then pressed into large bales of cotton which weigh more than 200 kilograms each.

Ecological cultivation

Cotton which is cultivated without any use of chemical biocides, artificial fertiliser or defoliating means and that has been watered with ground water can be called ecological. Cotton which hasn't been stressed forward with artificial manure and biocides will be of high quality, with long, level and soft fibres. This leads to products that will be durable for a long time and that feel good. Because of the fact that you cultivate ecologically you can use the finished clothes a little longer and through that you don't need to cultivate so much cotton and with that you save on the natural resources and discharges of poison. But if this is possible to carry through it will be required that many unite and agree that you really shall cultivate ecologically or else it will be hard for those who will cultivate ecologically when much work is needed.

From what we know from what has already been said in this article, ecologically cultivated cotton is a little more expensive than that which is conventionally cultivated. Ecological cotton has started to be cultivated in several places around the world though it is still cultivated on a very small scale and does not even account for 0.1 percent of the worlds' cotton production yet. But the quantity is increasing and ecological cotton is cultivated in for example Peru and some of the countries in Africa.

The processes of textile making

When cotton arrives at the weaving mill there are a lot of different processes waiting before the textiles are ready. In each and every one of these different processes the textiles will be treated with a large number of chemicals to give the fabric all the different properties that you want it to have.

Cotton fibres must not contain more than 0.05 ppm (if the sensitivity of the analysis method admits this) of one and each of the following substances: aldrine, captafol, chlordane, DDT, dieldrine, endrine, heptachlor, hexachlorbenzene, hexachlorcyclohexane (all isomers), 2,4,5-T, chlordimeform, chlorbenzylate, dinoseb with salts and monocrotofos.

Spinning/carding

The transformation from fibres to the finished fabric starts with the spinning mill where the fibres are carded and spun to threads and yarn. In the spinning mill people are only needed to provide the machines with new fibres, to supervise their work and finally to drive off with the finished yarn. As to the rest, the machines manage on their own. The fibres arrive at the spinning mill in hard packed bales which the machines will start to unpack. If the finished fabric will consist of two different fibres, for example cotton and polyester, the fibres will be mixed directly here before they are carded.

Spinning is in fact two processes, in the first one the mass of polymer will be pressed through fine nozzles to make “endless” fibres and to stretch them afterwards. In the other process a couple of fibres are placed together with a cord which forms a yarn.

Recycling Jeans

To decrease the friction (which otherwise leads to yarn breaks) the spinning process requires lubricants. These lubricants are called avivage or spinning oils and they often consist of mineral oils with additives of tensides to simplify the washing that will be done before dying and preparation. The spinning oils often contain a non-ionic tenside also to simplify when you wash off the mineral oil.

The demands of spinning oils are different for different natural fibres and different spinning processes being used. These demands are also dependent on the quality of the fibres and the contents of natural lubricants e.g. waxes. Cotton contains cotton wax, which decreases the demand for spinning oil.

The components of the spinning oil can be degradable in a hard way. Because of that there have been experiments to replace these with natural greases and oils. However it has become apparent that the risk of being attacked by mould and micro-organisms will increase, which in turn demands the use of preservatives. Re-use of spinning oils doesn't normally occur, one of the reasons for this is that it gives a more expensive recycling of the washing water.

Carding means that you put two fibres parallel together and then separate the gauze into card ribbons or stretch ribbons which means that the "pile fibres" are put parallel together again. Then you put the cord and the yarn is wound on bobbins. Carding, especially of natural fibres such as cotton leaves quite a lot of waste like fibre fragments, plant residue, dirt and short fibres. Most of this waste is thrown away, to landfill or can be returned to fields as an improvement agent for the soil.

Weaving

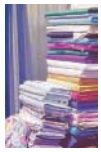
The production of woven textiles is relatively slow, even if the weaving-thread is put into the modern looms at very high speeds. These fast going looms demand regular lubrication. And the oils that are used for the lubrication are washed out during the preparation and end up in the washing water.

During the weaving process the warp-threads are protected from wear and tear thanks to the glue bath that you dip it in and that you let it dry afterwards. The warp glue usually contains starch, carboxy-methyl cellulose (CMC) or similar products for cellulose fibre as cotton for example. When the glue is put onto the warp or principle it only leaves a small amount of pollution when the fabric is washed out during the preparation process. The amount of glue runs up to 5 % of the fabric´s weight. In few companies they re-use some of the glue that has been washed out.

Preparation process

Singeing

Woven articles often go through a singeing before the wet preparation treatments. That means that the fabric is held over a gas flame to singe off naps on the surface. Otherwise they can cause problems during further treatments or once the garment is complete. This process causes air pollution which on the other hand is said to affect the environment very little.



Washing out

To accomplish the following processes you first have to wash out the glue agent from when you glued the warp. The most common glues have to be degradable before they are washed out, which can be done either through an oxidation with sodium sulphate mixed with alkali, or enzymatically with an enzyme which splits the farina, for example amylase. In most cases the washing out of the fabric is done in washing machines where the water flows against the direction of the fabric, in other words you wash against the counter-current to save water.

Earlier they used polyphosphates as binding agent when they washed the fabrics, but after the demand for lower usages of phosphate they now use EDTA, NTA or other phosphonates, which is much more effective even in low concentrations.

Substances which form complexes are always included in the chemicals which are used during the washing process. Cotton which has been prepared mechanically contains quite a lot of metals (calcium, magnesium and iron) which increases the hardness of the water. Substances which form complexes and mineral acids are used to remove these metals before bleaching and avoid the fibre material from becoming damaged.

After the fabric has been washed you generally use acetic acid for pH regulation. The remains of the alkalis don't have to be removed if the product is sent straight to bleaching after the washing.

Boiling of the fabrics

Fabrics are boiled in very hot water to remove various natural pollutions such as seed coats, waxes and pectines together with avivage and spinning oils that have been put on during the weaving process. Tensides and alkalis are used during this process. Seed coats and waxes are especially hard to wash out and demand high alkalinity and high temperatures to be removed.

This process always ends up with washing which means that the washing water will contain all types of spinning oils, knitting oils, weaving oils, glues, dirt, seed coats, waxes, pectines and wool fats. Besides that the water will contain chemicals from the cultivation and the manufacture such as pesticides, heavy metals and so on. Chemicals from the boiling and the washing also end up in the washing water. What the washing water exactly contains depends on the kind of fibre being processed, which chemicals are used for cultivation and manufacture and which techniques have been used for spinning and weaving. Facts of which effects this has on the environment are just partly known.

To determine the different variations and mixtures of these substances you first of all need the enviromental facts from the manufactures. The manufactures should be able to report on the content of pesticides and heavy metals, even if their existence can be modified through analysis of the waste water. But an analysis cannot modify where the contaminations in the textiles come from – that information has to come from the manufacturer.

When it comes to chemicals from the washing you will first of all demand facts on their poisonousness, biological degradableness and their ability to stratify in living organisms (bio accumulation and bio magnification).

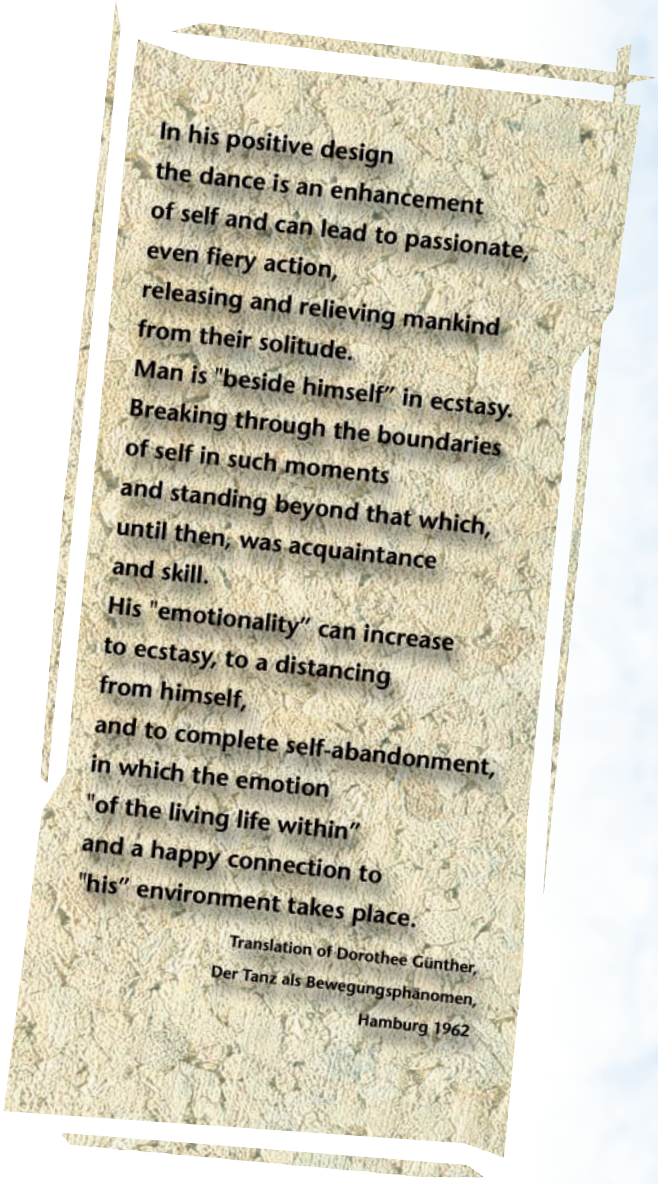
Recycling Jeans

Removing of the glue
In the removing of the glue you remove the glue that you had to impregnate on the warp threads to protect them from the mechanical wearing at the weaving. Today you use starch products, polyvinyl alcohol (PVA), polyacrylic acid (PAC) and carboxy-methyl cellulose (CMC) as glue substance. Galactomanan and polyester are also used. The glue substances have to be removed before dyeing and manufacture. Therefore the demands are that the glue should be easy to remove and withstand alkalis. It should also be easy to establish that the glue is gone from the textiles. Generally you remove the starch glue by adding enzymes which break down the starch and make it soluble in water.

Only Swedish weaving companies use glue on the warp thread. A big part of the textiles that are dyed and manufactured in Sweden are imported as raw materials that contain this glue. This implies that normally Sweden doesn't decide which type of glue they use.

The starch products are easily degradable. CMC, PVA and PAC are partly degradable. Some observations indicate that some of the modified starch glues are harder to degrade.. The glue substances constitute a big part of the waste water from the textile industries – often 50-80 %. The glues that are harder to degrade end up in the sludge of the sewage treatment works.

Did you know that? The waste water from the preparations often contains more than 50 % of the pollutions from the manufacture of the textiles.



Cleaning of the waste water

A sewage treatment work can use mechanical, biological and chemical cleaning methods. In the textile industry the mechanical step often is a strainer which filters the loose fibres from the waste water. In a biological step you let bacteria break down all substances that are degradable in an easy way into substances that are completely safe. If the waste water contains too much of for example heavy metals or preservative the bacteria will not do well and the cleaning works badly.

Chemicals which are hard to break down are cleaned through chemical methods. By adding special chemicals the substances can precipitate to the bottom as sludge. In this way the water gets clean, but the pollutants are left in the sludge. Sometimes the sludge is used as fertilizer on fields since it contains nutrients, but it's out of place if the sludge contains heavy metals and other toxic substances injurious to the environment. Instead a part of the sludge will end up in a refuse dump, but that's neither a good solution.

Bleaching

Almost all cotton yarns and fabrics are bleached to be clean and white. Once bleached the fabric is washed out very well before it's placed in the dye-bath. And after the dyeing the fabric will be washed again to remove the superfluous dye with washing taking several hundred litres of water per kilo of textile. It also takes much energy both to warming up the washing water and to dry the finished dyed fabric. The dyeing of textiles takes place in big industries which are called manufacture works. You use hundreds of chemicals during the dyeing, but not even a fraction stays in the fabric, most of it ends up in the sewage or in the air.

Right up to the nineteenth century you used the sun to bleach the cotton; nowadays strong chemical bleaching agents are used.

Bleaching with chlorine is a cheap and simple method. The disadvantage is the enormous emissions of chlorinated organic pollutants the bleaching with chlorine leads to. Despite that, this is the most common bleaching method in Europe and Asia.

In Sweden you use hydrogen peroxide instead, only in exceptional cases chlorine occurs here. Bleaching with hydrogen peroxide is getting more common abroad too, but this method isn't so good for the environment either. When you use this method you add EDTA, which is a substance that is not easily degraded. Despite that bleaching with hydrogen peroxide is considered the most lenient since it doesn't leave any residue in the drains.

The method which is most friendly to the environment is of course not to bleach the textiles at all, and it isn't an entirely impossible alternative. If you don't bleach the textiles before dyeing the shade of colour can change a little bit as time goes. This is more noticeable on light fabrics, on dark fabrics the difference doesn't appear at all. Not to bleach the textiles would in other words give a big profit for the environment, and if you compare, it isn't such a big loss to have clothes which aren't bleached before dyeing.

Bleaching with chlorine makes the jeans look extra worn, if it's added when you wash the jeans with pumice stone. An alternative to the washing with pumice is a treatment with enzymes, but it's quite unusual today. The enzymes makes the jeans more flexible without shortening

Recycling Jeans

their life. When the jeans are hanging in the shop and look all pretty and attractive they have been treated with rinsing agent which disappears right after the first wash. And since it's a minority of the Swedes who are using rinsing agent when they're washing their clothes and textiles it's misleading to treat the jeans in this way.

At the end of the bleaching process you rinse the textiles with acetic acid and formic acid, both acids are easily degradable.

Dyeing

About 3,000 different dyeing colours are produced in the world today. During the dyeing process, apart from dyes, you use different kinds of aids like tensides, equalize substance, substance which reduces the foam, substance for after-treatment and salts. The dyes and the other additives which remain in the dye-bath can very seldom be re-used and therefore it often ends up in the sewage. Both from the view-point of the environment and from the view-point of cost, it's important to decrease these dyeing residues both in the textiles and in the dyeing-baths. With many different preparation processes, for example mercerization and bleaching, you can increase the ability of the textiles to absorb the colours.

To decrease the amount of dye in the garment, you can cut down on the washing right after the dyeing, since it's then the garment loses the biggest amount of dye. On the other hand, this would lead to increased consumption of energy, washing detergent and water because the customer would have to wash the clothes (with a surplus of dye) separately.

Printing

On many of the jeans in the shops there are different types of prints. At the printing of these prints you use on the whole the same types of dyes as you use at the dyeing. Many other aids, for example tensides, binding agent and fabric softener from the dyeing are used for the prints as well.

How do you make jeans?

When you have got the completed textiles from the factories, you place them on the cutting table in layers of about 70-80 pieces. After that you lay a flat iron on top to keep the fabric in place when it's being pared.

If you are going to manufacture a new jeans model a pattern designer sits down and draws a pattern. To make ordinary jeans with five pockets you need about 17 different pattern parts. Then to get them into the right size you put the parts into the computer, which by means of a size curve, grades them.

All parts are being cut out with a textile-saw and are then being marked with a piece of chalk. A pair of jeans (depending on which model) requires about 1.25 m textile, 400 m thread, about 6 rivets, 5 buttons or 1 button and a zipper, and about 3 labels.

After that the pieces are transported in grade divisions to a factory. The jeans go through approximately 15 different steps in the process of completed jeans. Some parts are done by hand and some are computer controlled. Every part is being sewed in its own machine.

Some jeans are given a "used" and a "little rough" impression that you get through sandblasting. It is done by six employees that are working in three shifts. You literally shoot sand on the fabric with

a compressed-air pistol. It is special sand and the jeans are being blasted at a high pressure. The treatment takes away colour from the jeans, in some places like the thighs, the backside and knees, so that they look like they have been used and a little worn.

The blasting also makes them softer. There are machines that can do it too, but then every model and size has to be printed into the computer so that the blasting is correctly placed.

After the blasting or making (if the jeans are not blasted), they are transported to the washing industry. Every day two fully loaded trucks are sent from the factories. You could imagine that there are pretty many jeans then.

There the most common jeans are washed in a giant and fully automatic washing machine. For more advanced washes older washing machines are used.

If the jeans are going to have a dark colour they are washed in cold water during a short time. If they are going to have a lighter colour they are washed in water that has a temperature around 30-50 degrees Celsius. If you change the number of stones, water temperature or the size of the machine, the final outcome will change.

Did you know that:

- It takes about 15 minutes to manufacture a pair of jeans?
- About 2000 pairs of jeans a day are manufactured in a factory?
- 130 pairs of jeans that are being washed in an ordinary stonewash require 150 kg pumice and 682 litres of water?

`Different kinds of washings that exist with a short explanation`

Rinse wash.
Light waterwash that shrinks the material and washes away excess colour.

Stone wash.
The jeans are washed together with the pumice, which is a porous lava stone. The stone mostly tears on the seams and the edges.

Super stone wash.
The jeans are washed with pumice for at least 30 minutes. A lot of the colour disappears and the jeans look used.

Dark stone wash.
The jeans are washed with pumice, but not for such a long time. The effect is that the colour is kept and the washing effect gets more obvious on the seams and edges.

Tint.
The jeans are coloured before washing with yellow colour, which makes the jeans get a little dirty look.

Sand blasting.
Before washing, the jeans are treated by smooth sand that is sprayed under high pressure over them.

Moustache.
Before washing the jeans are treated with sandpaper that will give a torn, folded look in the crooks of the knee and in the groins. The jeans are guaranteed a “second hand look”.

Recycling Jeans

Broken twill.
A weaving style that gives an obvious zigzag effect on the wrong side.

Ring effect.
The fabric is weaved in a way that gives a characteristic striped look.

All of these steps in the process of completed jeans influence the environment through spills of chemicals and heavy metals.

Transport

When you see the jeans in the store you might not think of the fact that they have been travelling across the world a number of times. The jeans industry wants like every other industry to cut costs as much as they can which makes it put their factories where it is as cheap as possible and where there is cheap labour.

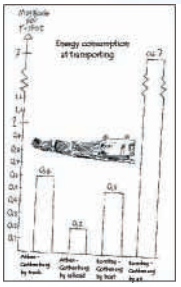
Did you know that:
The jeans have been travelling at least 3 times across the world before they arrive at your store?

The fibres are produced in one place, the fabrics are woven in another place and then they are sewed in a third place and then they are washed in yet another place. Clothes from Asia usually arrive on ships and the ones which are in Europe arrive on trucks, but because of the fact that the fabrics have become more of a "perishable" item they are therefore flown to Europe. Just think of the spills that are being discharged during their transport!

You might think that there are more spills through transporting the clothes from Asia to us, but that is not always correct. For example it takes less energy to transport a t-shirt from India to us by boat than to transport a similar t-shirt from Greece by truck.

Because of the demand more and more are sent from Asia by air, probably because it is cheaper in the long run. But 10 times as much energy is needed.

In Europe we have access to transporting clothes by railroad, but it is hardly ever used. Then there are different kinds of ways of transporting the clothes; in boxes or hanging. In order not to make them wrinkled you transport them hanging (mostly in Europe), which makes them take up to 5-10 times as much space compared to them being packed in boxes. That in its turn makes the energy consumption increase a lot.



Washing

Washing
We use about 40,000 to 50,000 tons of washing powder to clean our clothes every year. The consumption of fabric softener is estimated to be circa 10,000 tons. New clothes are often treated with softener to feel soft and look attractive in the store. These softeners vanish during washing. Since most Swedes don't use softeners when they're washing, it would give more truth to sell the clothes without additions like these.

Softeners are by the way totally unnecessary! For this reason there aren't any eco-labelled softeners either. So don't buy the things said in the commercial, save your money and the environment instead! Washing powder that includes a bit of soft soap works as well as softeners.

Even during washing both water and energy are used. And even if the washing machines and tumblers are using less energy than before, they still make us lazy and we wash more often than we actually need. And even though the newer machines use less energy than before, there are still older, more "energy swallowing" variants. Think of the environment and (this is usually a more effective way to reach out to people!) your own economy! By using energy saving machines and products you save both the nature and money. Another good way to save energy is to have a washing machine that is able to spin-dry well. Then the clothes dry a lot faster! Do also have in mind to fill the washing machine completely and that it's seldom necessary to wash at 60 degrees Celsius.

Did you know that washing at 60 degrees Celsius uses the double amount of energy than washing at 40 degrees Celsius?

Many people use environment-friendly washing powder, but they use far too much! The laundry doesn't get any cleaner if you increase the amount of washing powder. On the other hand it's really good to have a filled machine, because then the laundry is rubbed against each other and it helps the clothes getting cleaner.

Washing powder contains:

- Tensides to simplify the cleaning
- Complex makers that makes the water softer,
- Alkali

Washing powder meant for white laundry also often contains bleaching agent. They've also added whitening to make the clothes look whiter. You also add so called protection colloides to avoid dirt sticking onto the clothes again. Nowadays perfume and enzymes are added to the washing powder as well.

Dry-cleaning is the worst way of washing, if you consider the effects on the nature and environment. Nowadays Swedes use dry-cleaning less and less often.

After washing: Drying, ironing etc.
Even during drying, ironing and mangling our laundry we use energy. At the same time we use more and more different kinds of stain remover… which in its turn leads to an increased consumption of chemicals. Just look at the TV for a while, soon enough there will be a commercial brake and how often don't we see commercials for one after another of these miracle spot removers?! These commercials do affect us and our habits. There they only talk about how incredible something is. How often do we hear or see someone tell us about how this very miracle stain remover affects animals and nature after getting into the waste water? No, exactly, not that often!

Spot removers often contain solvents that many times are dangerous for the environment!

Resource usage during household washing

Energy usage
It is hard to find any good statistics about the exact amount of energy used by all households but there are some theories. We have found one example:

Sweden's population has a total "wash weight" of about 1.7 million tons. (This information is based on numbers when the population-size was about 8.5

Recycling Jeans

million people).

If Sweden's households wash half their laundry in 40°C and with an energy usage of about 0.3 kWh/kg and the other half is washed in 60°C and with an energy usage of 0.6 kWh/kg then the energy usage for Sweden will be about 765 million kWh. If you furthermore think about those 1.7 million tons that should be tumble-dried with an energy usage of 1 kWh/kg the total energy usage for washing and drying will be about 2,500 million kWh/year. (Ironing etc. is not included in that energy usage, but on the other hand, not all the laundry is tumble-dried so it's probably pretty even.) This amount corresponds to the electrical energy that is produced at the nuclear power plant "Oskarshamn 2" (situated near the city of Oskarshamn in Sweden).

Water usage

The water usage varies depending on if the machine that is used is old or new. On average about 40 litres of water are used for each washing time. That gives a usage of about 69 million m^3. That corresponds to about half the amount of water in a lake that is 6 m deep, 20 km long and 600 m wide.

What will happen to the old jeans?

Most of us Swedes have a hard time throwing away clothes in the refuse bin and perhaps that's not so strange if you think of how many who would be very grateful for your old jeans. Of course it feels better to give the clothes to different relief organizations and to people who need them. In former days we patched, fixed and sewed the clothes, nowadays you just wear and throw.

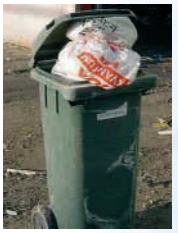
Even if textiles only represent about one percent of all household refuse it can create some problems because of all the chemicals the textiles have been treated with. Not counting our own waste of domestic textiles, there is about an extra 15 percent of the finished fabrics which become waste during the manufacturing process.

Right up to the nineteen-forties there were rag-and-bone men in Sweden. They collected old textiles which they sorted and sold again. Used cotton ended up in the manufacture of fine paper and became banknotes among other things. Today we use raw cotton to recycle cotton which already has been used. Some cotton waste still ends up in the manufacture of fine paper but today it's used for example in letter paper that is environment friendly. The cotton waste can also be sold as rags to workshops and printing works.

There are four main markets where textile waste could end up. Those two we already have mentioned (rags to the industry and fibres for the manufacture of fine paper) and burning as domestic refuse and recycling.

What at this point is discussed richly when it comes to textiles is those fabrics which are treated with bromated substances to make the textile flame-proof. Another problem is the heavy metals which occur in the dyes.

In Italy some companies have specialized in manufacturing yarn from short cotton fibres which have been left after the spinning process. You can spin yarn through mixing the cotton waste with about 20 % long polyester fibres, then you can use the yarn to make sheets among other things.



Resource usage

It is the wet treatments during the preparations in the textile process that consume the most of all the chemical, water and energy usage.

Electrical energy is used during the mechanical manufacture, but no other resources are. The electrical energy that is used is just enough to make the machines work. However, other resources are used during the wet treatments and in really large amounts. First of all, water is used (of course that's why it's called wet treatments), but also different chemicals to give the fabric all the different properties (like how it feels etc.), colour and print. Besides, a whole lot of energy is used to heat up different baths, to dry the textiles and in some cases for different types of warmth treatments.

The energy consumption varies depending on which manufacture method is used. You usually split up the wet treatments in two processes, continuous processes and discontinuous processes. Continuous processes means that the fabric is transported on a kind of conveyor belt through different units of treatment. That makes it possible to use one kind of bath for a longer time and then also for more fabric. Discontinuous processes are the opposite. Then the same tub is used for a special piece of the fabric. Then this tub must be emptied between each of the different steps. The energy and, above all, the water usage increases in the discontinuous process. At the same time a whole lot more chemicals are used then. As you can see, in discontinuous processes you use much more for the baths for each kg of fabric!

- Huge energy savings can be made by simple changes like not using "overlapped rinses" (which means that you fill the tub with water and you let the content be diluted and the water to run over the edge until the old content is gone.) By emptying the tub and then refill it a lot of water and electrical energy are saved! (It applies to the discontinuous processes.)

- During continuous manufacture energy can be saved by so called "counter-current rinse" Then the water is forced in the opposite direction than the fabric is moving.

The water that is used once can be reused, on the other hand the intensive society of today "forces" the companies to manufacture a big amount of fabric during a short period. Therefore it's rare to reuse the water since it takes so long to clean it. On the contrary for example the chill water that has gathered warmth can be used to take care of the warmth in it. This warmth can be used for both drying and heating of baths.

The most used tool during drying and heat-treatments is a special frame called Spannram in Swedish. You use it to adjust the dimensions of the fabric. Through that you can see and adjust to the dimensions of the fabrics length and direction by means of chains that goes along the edges. In "Spannram north" (a nordic project to work out better ways to save energy within these frames) they have come up with some recommendations which decrease the energy consumption. These are on the whole about to make sure that the outcoming air at drying has the maximum water vapour content that is possible, which leads to the fact that

fabrics don't need to have a lower water-content than textiles in ordinary room temperature and humidity have. The frames should also be equipped with special instruments which tell us how good these directions are followed.

It is not very easy to find any good statistics of resource usage for fabric manufacturing in Sweden. However, we have a table here which shows the energy consumption in the region of Älvsborg[2] .

Resource	Consumption/ kg produce textile
Oil	1.3 l
Liquified petroleum gas	0.23 kg
Energy	4.5 kWh
Water	187 l
Chemicals	0.6 kg

Energy consumption itself doesn't pollute nature if you just look at that area, but if you look at where the energy comes from, it's often from power stations that use coal or from nucler power plants. The power station that uses coal lets out a lot of carbon dioxide that rises up in the atmosphere and is a compounding reason for the greenhouse effect. Nuclear power plants don't affect global warming, but on the other hand it leaves radioactive waste and increases the risk of nuclear power accidents.

Chemicals

The word chemicals often makes many people think of toxic and dangerous stuff. Not all chemicals are toxic or dangerous however for the environment. There are different categories that you go through to decide if a chemical is toxic or not.

The first thing you do is to search for component parts in the chemical that exist on the list of "black components" – those ones that are classified as environmentally-dangerous or chemicals that might be dangerous. (See the "Begränsningslistan" which is given out by the Swedish National Environmental Protection Agency, the chemical inspection and the movement of protection for workers). After that you have looked if any of the components exist on the "Obs-list" (Same publisher). The "Obs-list" contains more components and it tells if some of them are important to exchange or something.

According to Swedish law anyone selling products like these have to give you information about environment and health aspects. Sometimes that information isn't totally correct though.

The dangerousity of a substance depends on three things. The first one is how biodegradable it is, the second one is how toxic the substance is and the third one is the bio accumulation/bio magnification.

The faster a substance is degraded, the less dangerous it is for the environment. – Pretty obvious, isn't it?! Even if it is degraded fast, but on the other hand is poisonous it can still cause a lot of damage to the animals and plants. So, logic tells us that a non-toxic substance that is degraded fast is less dangerous to the environment than a slowly degraded toxic substance.

So, how can you tell if it is degraded fast or slow? Also, how do you decide how toxic it is?

The biological degradation is tested during a certain time interval, usually 28 days. If the substance during that time is degraded more than 60% you say it is "easily degraded". From there the steps go upwards ending at "difficult to degrade".

[2] *Information from 1994, Textilmiljöhandboken – TEKOindustrierna, and they can't be seen as representation for today but they can give an idea of the situation.*

The toxicity is tested by exposing plants, insects or animals to the substance. Most expensive are the tests on fish, but that method gets the "best" results. The tests are carried out over a period of time, for example 2 days by dosing the amount of the chemical until half of the organisms are dead. Then you check what amount it was and compare it to the scale to see if the substance is toxic or not.

Bio accumulation is also an important part to consider when you estimate how dangerous a substance is to the environment. Then you look at how easily it is stored in living organisms, usually within fat deposits. Examples of substances that are "bio accumulatable" are DDT and PCB's.

It is important to know how toxic a substance is before it's released into the sewers.

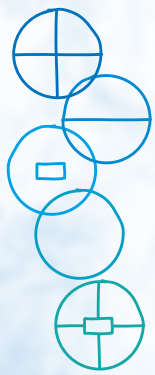
The sewage is cleaned partly by biological purification. If toxics, dangerous to these organisms, are released, the public cleaning departments efficiency can be seriously reduced.

In some places people are working hard to make countries reduce their use of certain chemicals. Sweden is a country that has actually come far in many ways regarding environmental work and many of the most dangerous substances have been banned for a relatively long time. Examples of such substances are:

- **Nonylphenoles** – part of detergents (the goal was that by the year 2000 the usage should have been reduced to 10% of the former amount. Sweden had reached that goal before 1996).
- **Benzidene** – is used in some places where artificial colours are made. Benzidene causes cancer and if you happen to consume some of the colouring that is made with Benzidene, it can be reformed in your stomach.

Even flame retardant affects the environment pretty seriously, especially if it is a brominated flame retardant. In the past people also used flame retardants with chlorine. Such chlorinated organic substances break down the ozone layer which has serious effects on the biosphere as well as on the rate of human skin cancer due to the greater amount of UV radiation reaching the earth's surface. The Swedish nature protection group is having a campaign for the ban of brominated flamed retardant. Brominated substancese, apart from also destroying the ozone layer, are stored in the tissue just like DDT and PCB. They are bioaccumulating.

There are rules that regulate the chemicals that are allowed to be used. It is said that some goods, e.g. clothes, may not be sold if they've been treated with or contain any substance that can harm humans. Nothing is said about substances dangerous to the environment. Neither do these rules say anything about manufacturing in other countries. So, fabrics made in Sweden have higher standards than imported goods. Why? This should only lead to companies choosing to import rather than producing these goods in their own country. Everything is about money, sad but true. Anyway, almost the only demands made on imported fabrics are that they can't contain any dangerous chemicals when the product is ready and in the shop.



Recycling Jeans

Thoughts and reflections

If you think for a while, you can think a little extra on how much humanity actually has accomplished here on earth during the later fraction of our time on earth. The effects of environmental pollution are well-known: eutrophicated lakes and poisoned oceans, acid rain, polluted lands and a large-scale spreading of heavy metals and other substances injurious to the environment in nature.

It doesn't make sense to increase the spreading of chemicals and artificial manure on the fields. In the end the soil will lose its ability to cultivate food. Changing the direction of rivers and pumping up the groundwater just for irrigation aren't any good ideas either if we want to keep on living here on earth at all. For a long time we have been using cotton and as we know it's suitable for composting. The snag nowadays is that you mix heavy metals and other poisonous substances into the cotton which makes it hard to compost. We therefore throw a spanner into the works for nature, so it will be hard to reuse.

Another important thing to mention is all the fuels that are used during the cultivation of cotton. Fuels are used during all mechanical cultivation, this kind of cultivation thus contributes to the greenhouse effect. Also child labour can occur when it's not mechanical cultivation.

Today environmental questions have a natural place in most governments all over the world, but it only helps if you do something about them, too.

It is also important to feel that we can have an influence. Often, we give up too quickly because we don't feel that we, as a small individual, have a chance against the big clothing companies. But don't give up! If we, as a collective, make demands on the clothes importers they will, to keep their customers and their sales, on their part make demands on the subcontractors. The result will be that just you can have an influence.

And back to the question we had in the beginning where we asked ourselves (and you?!) how you can make the market for ecological clothes bigger? An alternative could be to give contributions to companies which go in for ecological cultivation and manufacture. In this way they wouldn't have to take such high prices on their products to cover the manufacture costs. Then, more people would choose ecological clothes! – Again everything is about money, in some way. You should also put a little more money on advertising, to make people aware that there really exists something called "ecological clothes". How is it possible to buy something we have never heard of? It feels like a rather obvious point to increase the market for ecological clothes. And are we supposed to know that "ordinary" textiles affect the environment as much as they do? – NO! We want more info!

And, don't forget!! – YOU can make a difference!!!

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Recycling Jeans

Pictures

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61 Bin Thinking
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Chapter 2: RE-USE

We are not to throw away those things which can benefit our neighbour. Goods are called good because they can be used for good: they are instruments for good, in the hands of those who use them properly.

Clement of Alexandria (150?-220?)

Production of Bio-diesel from Waste Fryer Oil

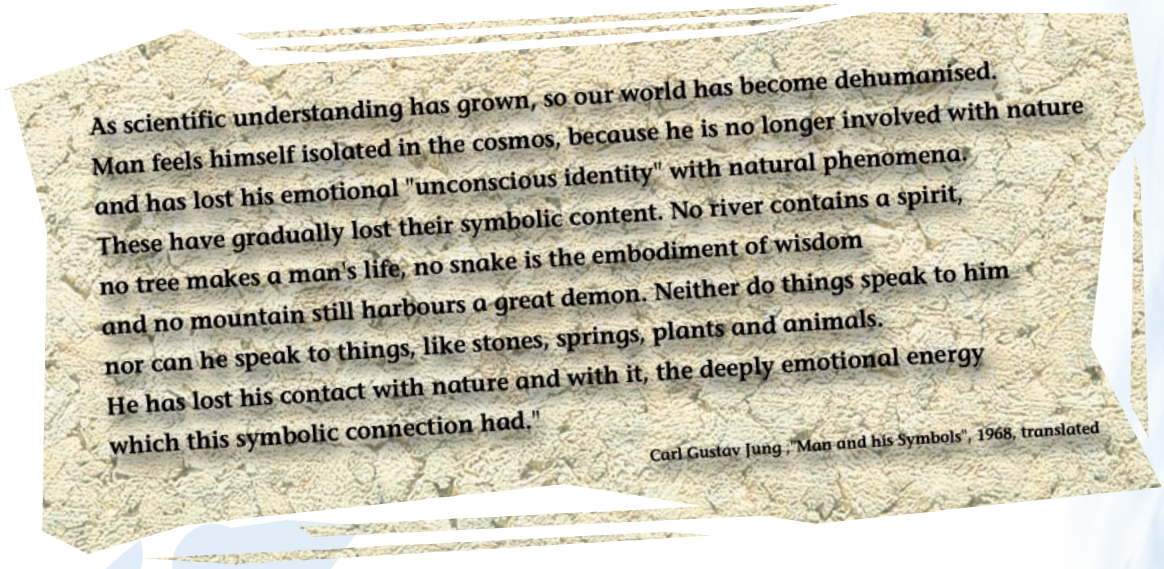
by Bernhard Gerstmayr

McDonald's Deutschland is recovering a high-quality secondary raw material out of waste fryer oil. This secondary raw material can either be turned into biodiesel for lorries or it can serve as fuel in combined heat and power units (CHPs) to produce electricity and heat. Both usages finally save fossil fuels like coal or natural gas and reduce the production of environmentally damaging carbon dioxide (CO_2). Complex technical and chemical processes are hidden behind the production of biodiesel from fryer oil, which will be described in this article.

With over 1,260 restaurants, McDonald's is Germany's largest catering business and has around 49,000 employees. This year, the company has been linked to the football World Cup in Germany as McDonald's was one of the main sponsors. In Germany, however, McDonald's is also known for its commitments to other areas: for example its extensive environmental programme, which is controlled from an in-house environmental department in the main service centre in Munich, and continues to be further developed.

Commitment to recycling management as part of the environmental programme

As early as 1987, McDonald's Deutschland Inc. pledged in its environmental programme for the first time to work as environmentally soundly as possible. For example, in the production of packaging, it is made sure that environment-friendly raw materials are used. Approx. 80 % of the packaging material today comes from renewable materials. All restaurants in Germany have waste separation bins so that the residual waste can be separated according to material. The recycling quota of the residual waste accumulating in the



German restaurants, as specified by the McDonald's Deutschland environmental department is at about 90 %.
Even safe recycling methods for the organic residual waste from the German restaurants are a pillar in McDonald's environmental programme. For example the company entered unknown territory even before the feed ban on old cooking fat in the European Union and together with waste management companies developed innovative recycling processes for the restaurants' waste fryer oil.

The waste from frying chicken

McNuggets®, Fillet-O-Fish, apple pies, fries etc. really adds up. In 2005 about 8,500 tonnes in waste fryer oil were produced. Duly before the fryer oil reaches the thresholds as specified by the food law, it is changed for fresh vegetable oil and collected into special containers. 1-2 times a month a waste management company transporter drives to each restaurant and changes the full containers of waste fryer oil for a new empty container. A sophisticated treatment process begins once the oil is delivered to the recycling plant, where a high-quality raw material for energy processes is produced from catering waste – perfect recycling management

Safe waste disposal methods

Only certified waste disposal specialists are allowed to dispose of waste fryer oil. Companies, which meet certain quality criteria, can become "waste disposal specialists". These quality criteria were set in the Recycling Management and Waste Act in Germany. The Act came into force in 1994 and forms the foundation of the German waste legislation.

Through regular waste disposal company audits, the environmental department tries to ensure that the waste is disposed of in the legally required manner as defined by legislators. The McDonald's experts therefore spend a day going over the company with a

Fig. 1: A bag of crisp French fries High-quality vegetable oil is used for the frying process. These oils guarantee an even frying process and so ensure the well-known hearty flavour of McDonald's French fries. Source: McDonald's Deutschland Inc.

fine-tooth comb; check the processes and a variety of documents. Discrepancies are immediately questioned and diversions to the target state must immediately be corrected by the disposal company.

Fryer oil – a sought-after raw material

The increasing prices at petrol stations for mineral diesel are making the McDonald's waste fryer oil become a sought-after raw material. It is also especially well suited, after the frying process, for the production of biodiesel. So that the oil can drive a passenger car as well as mineral diesel, it is initially heated up by specialist companies, filtered and finally its chemical properties are changed in a multi-stage process (transesterification).

In an additional utilisation process, conventional diesel engines were adapted in such a way, that they are able to burn old cooking fat after sanitation and fine filtration without chemical conversion and therefore able to power a generator.

Vegetable oil, the basis for the McDonald's fryer oil, could essentially also be used without chemical changes as a fuel replacement. After a while, the combustion in standard engines, however, would cause deposits to form, so-called carbonisations. It also could not be ensured that it would be suitable in winter or that it would adhere to the legal emission thresholds. These technical problems can either be rectified through special types of engines (e.g. Elsbett engines) or by subjecting the fryer oil to a transesterification process. But what happens during this process?

The transesterification process

In vegetable oils and fats the fatty acids are connected to a glycerine molecule via ester bonds. One such molecule is called triglyceride. Transesterification describes the chemical process, where by adding methanol and a catalyst (potassium hydroxide), three biodiesel molecules and a free glycerine molecule develop from a triglyceride molecule.

Fig. 2: Combined Heat and Power Unit (CHP). A Type 6 H 280 diesel engine from the Herford engine factory with low rpm was specially adapted for use with waste fryer oil from the German McDonald's restaurants. The electric power produced by a generator is fed into the power grid. The waste heat can be used for industrial applications. Source: Berndt GmbH, Oberding

Glycerine, in turn, is used in the chemical and pharmaceutical industry or serves as an energy substrate for biogas facilities.

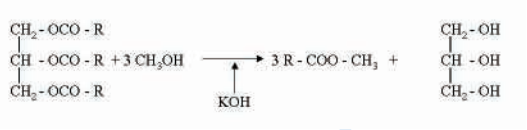
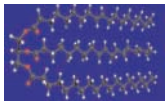
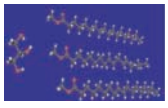


Fig. 3: Adding methanol (CH_3OH) and the catalyst potassium hydroxide (KOH) to the vegetable oil results in a fatty acid methyl ester and a free glycerine $C_3H_5(OH)_3$. The process only takes place endothermically therefore with the addition of heat (approx. 80°C).

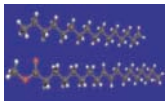
The resulting biodiesel molecules are very similar to mineral diesel molecules and therefore show comparable properties, as can be seen in the following illustration. They are referred to as fat methyl ester, according to their chemical compound. Depending on the input material, rapeseed methyl ester (RME), fat methyl ester (FME), alternariol methyl ester (AME) etc. are available on the market.



Triglyceride (1)



Free glycerine and three biodiesel molecules (2)



Diesel and biodiesel molecule (3)

Fig. 4: Molecule structures before (1) and after (2) transesterification as well as the comparison of a fossil diesel molecule with a biodiesel molecule.

The similarity in appearance between mineral diesel and biodiesel molecules also means comparable properties and even clear advantages for the biodiesel in significant areas.

Advantages of biodiesel

A biodiesel cetane number (flammability) is essentially higher (approx. 54) than that of a mineral diesel (approx. 48 nonadditized, approx. 52 additized). The advantages are a lower ignition delay and a reduced increase of pressure in the cylinder. Since the biodiesel also has a high lubricity, it improves the operational performance of the engine and clearly reduces engine wear.

In addition to these advantages for vehicle owners, the environment also benefits from the use of biodiesel instead of mineral diesel.
The advantages of biodiesel combined are:

- produced from renewable raw materials
- sulphur-free (< 0,001 %) => improved catalytic effect
- burns well due to the high oxygen content of about 11 %
- reduction of the emissions in hydrocarbon and carbon black
- contains no benzene or other aromatics
- readily biodegradable and low hazard to water (Water Hazard Class 1)
- no hazardous material (flash point min. 120°C in accordance with DIN EN 14214)

Disadvantages of biodiesel

Despite the above advantages, when using biodiesel some technical challenges have to be overcome and maintenance and repair costs taken into account. Large fleet opera-

Fig. 6: Biodiesel truck of McDonald's distributor WLS GmbH in Germany. McDonald's attaches great importance to environment-friendly processes in the supply chain. Therefore, all restaurants in Germany are supplied by biodiesel trucks.
Source: McDonald's Deutschland Inc.

tors report a fuelling increase of between 2-5 % in lorries compared to mineral diesel. This is an effect of the different specific energy contents.

Based on its solvent properties, biodiesel can lead to deposits forming in fuel lines and in tanks and filter systems becoming blocked. Experience has shown that the maintenance rates with changing the engine oil and the fuel filter increase and the life expectancy of the fuel-injection system can decrease due to higher pressure and an increase in temperature. These characteristics must be taken into consideration before changing the fuel to biodiesel so that the costing advantages, in comparison to mineral diesel, are not negated through high operating costs.

Quality assurance

To ensure engine operation is as trouble-free as possible, the biogenous fuel must have minimum quality properties (in accordance with norm DIN EN 14214). Under the term "Bio-Diesel", fuel in Germany may only be offered based on the 10th Federal Immission Control Ordinance and corresponding to the specific values of the DIN (Deutsche Industrie-Norm, German Industry Norm), so that vehicle owners do not feel deceived about the properties of the biogenous fuel at the petrol station.

With the transesterification of waste fryer oil, some features compared to pure rapeseed oil need to be taken into account in order to guarantee a high-quality end product. Consequently the oil, which has already been subjected to a heating treatment in the fryer, contains polymer esters. These polymer esters must be separated by distilling the biodiesel. In order to achieve a highest possible biodiesel yield, an esterification of free fatty acids in the fryer oil takes place as well as transesterification.

Contribution to environmental and climate protection

In 2005, innovative recycling processes for the fryer oil from all the McDonald's restaurants in Germany saved about 25,000 tonnes in carbon dioxide. A driver of a passenger car could drive around Earth about 4,500 times with this huge amount of emission of carbon dioxide! Filling up motor vehicles with biodiesel instead of fossil diesel also reduces the amount of sulphur oxides (-99 %) and nitrogen oxides (-5 %) entering the environment. Both fuels are known as being jointly responsible for acid rain, which is one of the main causes of forest dieback. Using biodiesel also reduces the amount of carbon black produced, on average by about 40 %. Less carbon black in the air in turn means less damage to people, fewer illnesses and deaths and therefore also a reduction in economic losses. There is also an indirect positive benefit to the climate if the glycerine, which up to now is produced from fossil fuel, is replaced by renewable glycerine.

Conclusion: despite some substance-specific disadvantages, using biodiesel as a fuel for lorries has clear advantages for the environment, society and also for the relevant lorry operating companies.

The supplying lorries, which are run by the McDonald's distributor in Germany with head office in Duisburg, incidentally all run on rapeseed oil-based biodiesel. However, the environment-friendly fuel alone does not satisfy McDonald's and its distributor: consequently all drivers receive regular training in fuel-economising driving methods. Having travelled about 80 million kilometres in the last 6 years, McDonald's and its partner can come to a positive conclusion: the use of biodiesel has proved itself, teething problems have been rectified and a great

Bio-diesel from Waste Oil

contribution is made each day to the protection of the environment.

Conclusion

We consider the business use of biogenous raw materials to be very promising for the future. As McDonald's proves daily through its biodiesel lorries, supply chain management offers excellent possibilities to improve a product's ecobalance. If a company recognises residual waste from production processes not just as waste but as a secondary raw material, this contributes significantly to a lasting recycling management. Together with partner companies, McDonald's Deutschland began early to develop innovative recycling processes for waste fryer oil and therefore set standards. In this way, the vegetable oil does not just ensure tasty fries and delicious apple pies, but also helps to lower emissions on Germany's roads and to make transport more environment-friendly.

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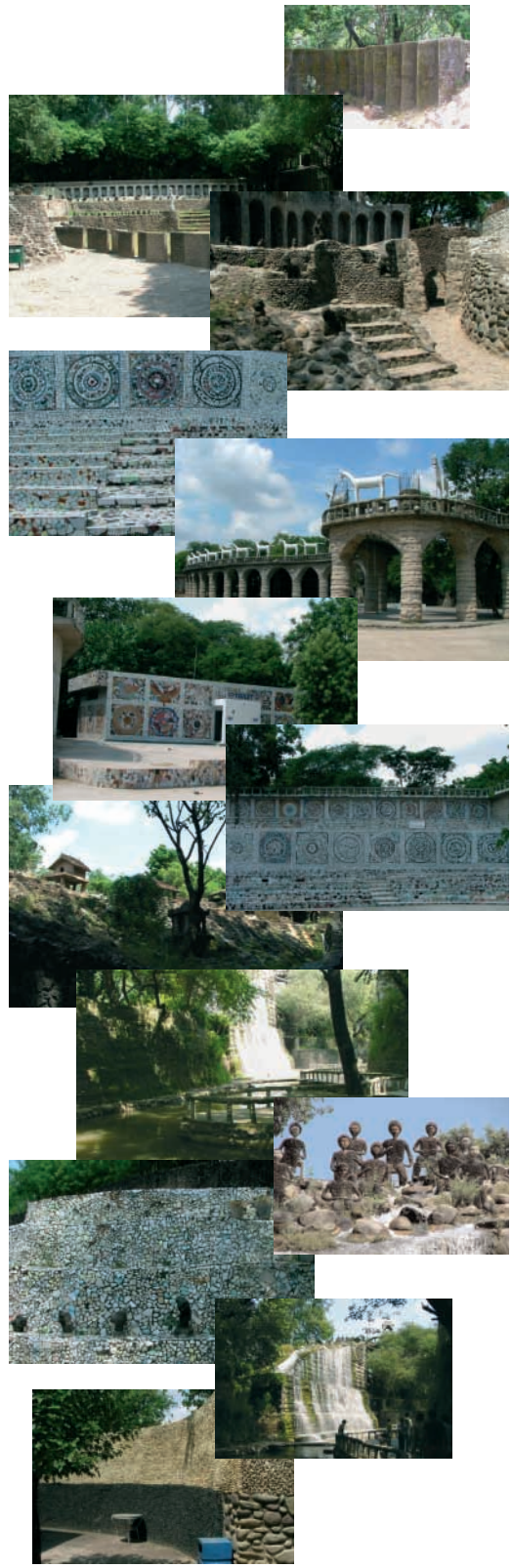
Fig. 5: Biodiesel Production Plant. State-of-the-art systems engineering makes a biogenous fuel out of waste fryer oil: methyl ester or "biodiesel" Source: PETROTEC GmbH, Borken

From Municipal Waste to a Fantasy Land

by Neelima Jerath

Chandigarh, 'the City Beautiful' is one of the best examples of urban planning in modern India.



With a breathtaking backdrop of the Shivalik ranges of Himalayas, the city is known as the 'City of sun, space & verdure'. The city provides home to a number of gardens, but the one which has captured the imagination of one and all, and has been clicked by a million cameras, is the Rock Garden - an amazing creation of human ingenuity weaving municipal and natural solid wastes in to inexplicably awe-some art forms! Created by an innovative road inspector working in the Public Works Department of the government, Mr. Nek Chand, the garden is an important land-mark which has brought Chandigarh to the realm of international tourism. The rock garden provides an unparalleled example of what human ingenuity can do to things discarded and rendered worth-less by human beings themselves.

Where the rock garden stands today, was a dumping ground for municipal waste from where its creator picked up innumerable pieces of discarded materials like broken sanitary ware, crockery, electri-cal fittings, discarded street lights, metal

from Waste to Fantasy Land

wires, play marbles, bottle corks, frames, handle bars, mudguards, burnt bricks, stones & pebbles, broken bangles and even human hair recovered from barber's shops. What has emerged out of these waste materials is a daring concept with perennial appeal which leaves the visitors spell bound, only to return again and again.

The layout of the garden is based on the fantasy of a lost kingdom. As one meanders through a variety of low doorways, archways, vestibules & lanes made of electrical cut outs, broken chinaware, burnt cinders and the like, one comes across several different chambers, each with a distinct theme. These include a forecourt, a music chamber, the main court, a series of water falls, open air theatre and make believe villages, mountains, over bridges, etc. The main court is adorned by the king's throne flanked by his courtiers and subjects, with the queens and the royal ladies overlooking the proceedings of courts through veiled arches made of broken chinaware, pebbles and ash balls. As one passes through the garden, one also comes across vast areas depicting a series of human & animal forms made from broken glass, crockery, play marbles, bottle corks & discarded pottery. Besides, beautiful maidens, robust men and playful child forms, one can find families of elephants, monkeys, bears, cats, dogs, camels and beautiful birds. The section depicting colourful women and birds made of broken bangles is especially interesting and one marvels at the patience which would have gone in to segregating bangle pieces of different colours and placing them side by side to create designer clothes and multi-hued feathers. An open air theatre and a vast pavilion with a centre stage made entirely of broken chinaware also blends well with the natural landscape and existing vegetation and forms an interesting activity area.

The garden is indeed a rare example of **a very aesthetic reuse of unaesthetic materials.** It is used both, as a recreation and non-formal teaching area for school children and general public. The creator has been nationally and internationally acclaimed and has achieved several awards for his rare feat.

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On the BSP Learners' Guide 7 website:
More articles, further information, worksheets
http://www.b-s-p.org/lg7

Chapter 3: RE-THINK

"Let every individual and institution now think and act as a responsible trustee of Earth, seeking choices in ecology, economics and ethics that will provide a sustainable future, eliminate pollution, poverty and violence, awaken the wonder of life and foster peaceful progress in the human adventure."

John McConnell, founder of International Earth Day

Energy and Climate 21: Scenarios for the Climate of Tomorrow

by Martin Jarrath, Andreas Koch and Patrick Rump

This paper looks at global warming in the 21st century. Based on an analysis of the last 175 years we are venturing to compile a projection of the global climate for the entire 21st century. With the assistance of the associated climate software "Energy and Climate 21", the connection between fossil energy consumption, fire clearances and global warming in the 21st century can be simulated in detail enabling different considerations of the energy sources, fire clearances, groups of states and many others to be carried out.

This paper together with the associated software is designed for group work that can be divided up between the group-members and the Group Puzzle Method in Upper Secondary Level.

The current version of the software is available at http://www.agenda21now.org/ec21.

Preface

At the end of January 2006 when we were writing this paper, Russia was experiencing the most extreme cold winter days for decades. At the same time for two weeks the snow at Spitsbergen had been melting near the 80th parallel in the Arctic and on one afternoon in mid-January 2006 the thermometer there rose to +7 degrees centigrade, a record since weather recording began.

Global warming? Or just normal climate fluctuations?

Well both. We find ourselves in the midst of a global warming. Once again the past year (2005) was the warmest since measurements began. In the last 175 years since the start of the Industrial Revolution the

average temperature worldwide has increased by 0.7 degrees. And there are strong indications for the fact that we humans have triggered this warming and are still in the process of intensifying it.

How much is a warming by 0.7 degrees? (To be perfectly correct, kelvin should be used instead of degree, when talking about a difference in temperature, but we are using the more established term.) Your first thought on this may be, if you have never been involved with global warming before: 0.7 degrees – that is so little that it will be hardly noticed. But is that correct?

And how much global warming can be still expected in the rest of the 21st century? And what will be the implications?

You will not gain any conclusive answers to these questions if you read everything that we have written in this paper. But you will be aware of some partial answers - and even better: You can find your own partial answers to your own questions if you use our climate simulation software "Energy and Climate 21" as described in this paper and then assess the results.

The most up-to-date version of the software for this chapter can be located on our website at http://www.agenda21now.org/ec21.

And if you are one of those people who are able to write computer programmes then you are invited to further develop "Energy and Climate 21" since EC21 is Open Source software.

How you can work with this article:
In order to obtain meaningful answers to global warming in the 21st century, you do not have to work through everything from the start to the end.

- The best thing to do is to first install the "Energy and Climate 21" software (abbreviated to EC21) on your computer. The software starts automatically after installation if you want it to.
- Read the section "Introduction for Everyone" in this article.

In case you want to know more: Please read the Knowledge Modules after the Introduction. Work through those modules that interest you. Which modules you read and in which order is not crucial. In every module you will learn more about global warming and its simulation with EC21. When you have worked through everything, you will be a real expert!

Tip for Educators:
This article and the EC21 simulation software are suitable for group-work teaching methods such as group work, expert systems or "knowledge puzzles."

- All pupils read the "Introduction for Everyone" first.
- The individual Knowledge Modules can then be worked through in groups and they are largely independent from each other.

M0: Introduction for everyone

When you have read this introduction you can use our simulation and view and assess the first results. Now start "Energy and Climate 21" on your computer, if you have not already done so.

What is "Energy and Climate 21"?
"Energy and Climate 21" (abbreviated to EC21) simulates global warming through carbon dioxide in the 21st century. The carbon dioxide concentration in the

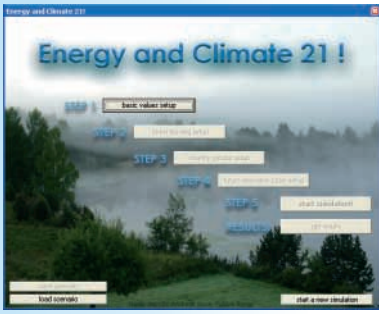


Figure. 1: Start Window for "Energy and Climate 21" (EC21) Software

atmosphere has considerably increased in the last 175 years from 280 ppm (parts per million) in 1830 to 380 ppm in 2005. During this period it has become significantly warmer on the earth with the average temperature worldwide having increased by 0.7 degrees. Carbon dioxide is a greenhouse gas. This means that it absorbs heat radiation. The more carbon dioxide that accesses the atmosphere, the warmer the earth becomes. Climate research has shown that the increase in the carbon dioxide concentration in the atmosphere and the global warming by 0.7 degrees are closely related.

The carbon dioxide concentration in the atmosphere is increasing because tropical forests are being irretrievably cut down and burnt, but primarily because humans consume energy. The so-called fossil energy sources such as coal, crude oil and natural gas are our most important sources of energy. In the burning of these energy sources carbon dioxide is released and in 2005 for example this amounted to approximately 25 billion tonnes worldwide.

EC21 illustrates the rise in the carbon dioxide concentration in the atmosphere from 1830 to the present day and enables its further calculation up until 2100. Using these data EC21 simulates global warming in the past and the future.

How much the carbon dioxide concentration in the atmosphere will rise in the 21st century depends on the quantities of fossil energy sources of coal, crude oil and natural gas that are used in the future.

Nobody knows the future consumption of these energy sources. But perhaps we could make a couple of interesting assumptions on this subject? Input your consumption assumptions into EC21 and the software will simulate how intense global warming will be through CO_2 in the 21st century. Compare the different scenarios and draw your own conclusions!

You will now learn how to do this.

Introduction to the operation of EC21
We will now have a quick look in the application window of the software you have started – "Energy and Climate 21".

Can you see the buttons with the Steps? The first time go through Steps 1 to 4 in sequence. Here you will later input a few settings.

Recommendation: Do not change anything initially in the settings for Steps 1, 2 and 3.

Step 4.1: For the moment leave all the settings here unchanged and select "Proceed to step 4.2".
In Step 4.2 the time period 2006 - 2100 is pre-set. For the moment also leave the time period unchanged. Click on "apply period" and then "finish".

Now you have entered all the necessary pre-settings for a climate scenario.
(In reality you have of course not input one single pre-set, but only followed the instructions, but now you know where you can enter your own individual settings, when you have familiarised yourself with the system).

Now Step 5 - the simulation - follows.
Click on Step 5 and first of all give your scenario a name. Then the simulation will run and the results will be displayed. Every simulation starts in 1830 and ends in 2100. EC21 works with historical data up to 2005. From 2006 onwards **you** determine the scenario with which will be calculated. Currently you have just run the pre-set scenario.

Now return to Steps 3 and 4 and look at the settings: A global "Zero-Scenario" is pre-set. The assumption here is that worldwide the energy consumption - or in other words the consumption of the fossil energy sources of coal, oil and natural gas - will remain constant in the future from 2006 onwards and during the entire period until 2100. Please note that "Zero-Scenario" does not mean "Zero Consumption" or "Zero Emission" but "Zero Increase": The emissions remain constantly high at the value of 2006 until 2100.

Take a closer look at the simulation result: At the top you will see a table with different rows of values for the years 1830 to 2100 with an empty graphic underneath.

Now select which row from the table should be displayed as a graphic. Suggestion: Select – and click on – "CO_2 concentration [ppm]". Then click on "draw selected item" and you will see the graphic display as shown in the following illustration.

If you want to look more closely at the precise values - they are displayed in the table at the top at the side.

You can add further data rows to the graphical display.
To delete a data row out of the diagram, click on "clear series". Or you can delete all the data rows at the same time by clicking on "clear all".

If you would like to see a particular graphic in detail, just mark it by clicking on it and drag the section to be enlarged with the mouse.

"Reset view" resets the total view.

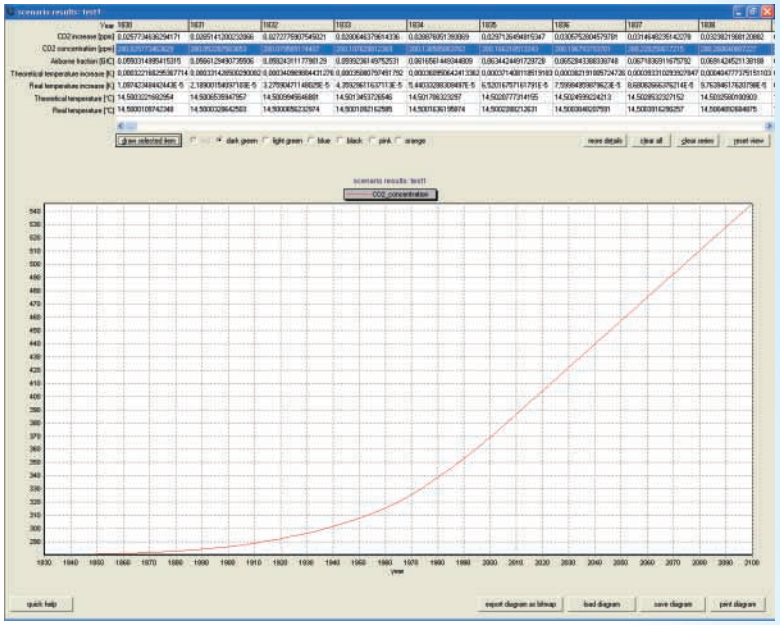


Figure 2: Simulation Results Presentation

Tasks:

1. Simulate the global Zero-Scenario as described above.

- Create a graphical display of the carbon dioxide concentration in the atmosphere.
- Describe the development of the carbon dioxide concentration in the atmosphere between 1830 and 2100 for the global Zero-Scenario.

2. Set up a new scenario: The "Plus-One" Scenario.

- Start in Step 1 and continue until Step 4.2.
- In Step 4.2 set the values for all three energy sources to "1" (this means 1% increase per year).
- Continue until the simulation in Step 5 and display the results.
- In the graphical display the CO_2 curve of the previous scenario is still available. Add the graphic of the CO_2 concentration of the atmosphere for the new scenario.
- Compare the two curves!

Very Good! When you have got to this point you can use EC21 successfully!

You have certainly noticed that EC21 offers many settings options. Would you like to know more precisely how the simulation works?

And would you like to obtain realistic, usable statements on global warming in the 21st century?

Select from the following Knowledge Modules M1 to M11 those which interest you in order to learn more. You do not have to work through all Knowledge Modules and the order you select them is not really important.

M1: About greenhouse gases

In early 2006 the earth's atmosphere contained approximately 380 ppm (parts per million) carbon dioxide, i.e. 0.038%. Despite the small concentration this gas has a huge influence on the temperature of the atmosphere as it has a specific property. For visible light it is completely transparent, but it absorbs thermal infrared rays – heat radiation – and there are consequences to this (see Figure 3):

Take as an example a green meadow in a park in your city on a sunny summer's day. The white light of the sun's rays falls on the meadow and the meadow appears very green to you. This means that the meadow is reflecting the green part of the sunlight (for this reason it is green in colour) and the incident red and blue light is however absorbed by the meadow. Through the absorption of the red and blue light, the meadow warms up. This means that it transmits more heat radiation than previously and this can be made visible using an infrared camera for example. Now the carbon dioxide comes into play: Carbon dioxide prevents this heat radiation being radiated out into space as it absorbs a large part of these rays. In this way it warms up and then itself transmits heat radiation which in part is re-transmitted back in the direction of earth. The result is that the atmosphere warms up. How intense the warming is depends on the volume of carbon dioxide. The more there is, the higher the temperature will rise in the atmosphere.

This process is called the greenhouse effect because the glass panes in a greenhouse act in approximately the same way as carbon dioxide in the earth's atmosphere: They also absorb heat radiation, heat up and then transmit their heat radiation back to earth. Therefore under the glass panes of the greenhouse it is warmer than outside.

The greenhouse effect is not bad in itself - on the contrary it is essential for life for us. Without the natural greenhouse effect, which is primarily caused by water vapour, but also by carbon dioxide, the average prevailing temperature on earth would be -18° centigrade. The actual, global average temperature is currently approximately +15.2° centigrade.

Water vapour, carbon dioxide and other trace gases lead to a natural greenhouse effect of about +33 degrees. This is essential for our life.

For about 200 years and with increasing intensity in the last decades, human beings are interfering in the natural greenhouse effect. By keeping warm, moving around, operating machines and generating electrical current, fossil energy sources are burnt - namely coal in the form of hard coal, oil and natural gas. These energy sources were originally created out of animal and vegetable remains and therefore consist of carbon compounds. Carbon escapes into the atmosphere during combustion in the form of carbon dioxide, thereby causing an additional, artificial greenhouse effect. This artificial greenhouse effect leads to an

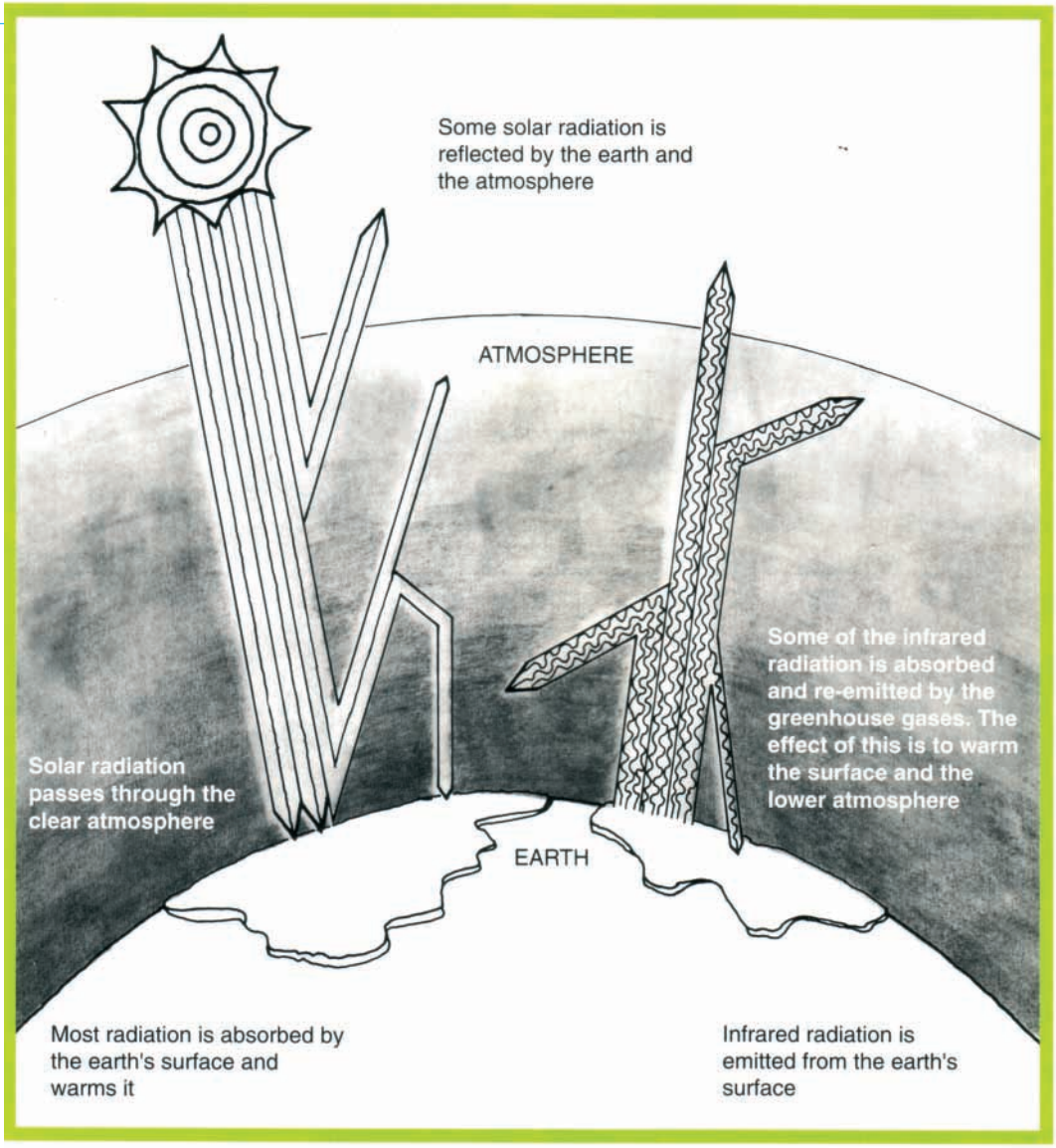


Figure 3: Schematic Presentation of the Greenhouse Effect. From: [Bo], p. 9

additional warming of the earth's atmosphere.

The burning of forests, such as tropical rain forests also creates a huge amount of carbon dioxide which remains in the atmosphere if the fire-destroyed areas are not recultivated through reforestation schemes.

Task 1: Start the software. Select in Steps 3 and 4 the global Zero-Scenario (more information on this can be found in the Introduction for Everyone). Run the simulation and display the results. There click on the button "more details": Display the carbon dioxide emissions ("total emissions").

Please remember: The 1830 to 2005 values are calculated from historical data and from 2006 the current scenario is simulated, therefore here the Zero-Scenario.

The unit of measurement used here is gigatonnes – billions of tonnes – carbon dioxide, abbreviated to GtC. This carbon is contained in carbon dioxide (CO_2). These molecules consist of one carbon atom and two oxygen atoms each. One gigatonne of carbon is therefore embedded in 3.67 billion tonnes of carbon dioxide.

The energy generation from fossil energy sources has grown constantly since the industrial revolution, and so have the CO_2 emissions: In 2005 about 9 GtC were released due to activities by humans, of which 7.3 GtC was through the combustion of fossil energy sources and between 1.5 and 2 GtC through the burning of forests, especially tropical forests.

Task 2: Display the carbon dioxide emissions from the combustion of the three fossil energy sources (coal, oil, natural gas). (Note: The way to do this is very similar to Task 1.) Compare them. State the commonalities and the differences! Try to find an explanation!

Since the start of industrialisation, the carbon dioxide concentration in the atmosphere has risen from a level of 280 ppm in the year 1830 to today's 380 ppm. And it continues to rise by 1-2 ppm every year.

In the same period the earth's atmosphere has significantly warmed up and the global average temperature has increased by 0.7 degrees. It is therefore obvious that a connection can be seen here: Climate scientists have calculated that a doubling of the carbon dioxide concentration in comparison with the pre-industrial era (therefore an increase of 280 ppm to 560 ppm) would cause an increase in the global average temperature of 3.5 degrees.

Task 3: Find out in which year in a Zero-Scenario 560 ppm of carbon dioxide concentration will be achieved.

M2: Impacts of global warming

What are the impacts of the warming to date of 0.7 degrees?
What is to be expected in a warming of 3.5 degrees that will occur if the CO_2 concentration in the atmosphere rises to 560 ppm – this would be a doubling of the 280 ppm from the pre-industrial era?

At first sight 0.7 degrees seems to be very low.

The global warming to date of 0.7 degrees has had for example the following implications:

- The glaciers in the Alps and other mountain ranges in the world have shrunk considerably.
- The warming is not equally intense everywhere: In high geographic latitudes such as the polar areas, it is more intense than in the tropics.
- The polar ice caps in Greenland and the Antarctic are thawing slowly at the edges. The melted snow and ice raises the sea level.
- A large part of the Arctic Ocean is covered with sea ice the entire year. This all-year ice-covered surface has become significantly smaller. The dark water now absorbs solar radiation whereas in the past the ice largely reflected it. This leads to additional warming.

- The water in the oceans is warming up and therefore expanding. This leads to a rise in sea level. Together with the melted snow and ice from thawing glaciers in the Antarctic, Greenland and on high mountains, a rise in sea level of currently 2 millimetres per year is occurring.
- Tropical cyclones such as hurricanes occur over seas whose surface temperatures are at least 28°C. Due to the warming of the oceans, the surface over which such cyclones can occur is increasing. And the time period in the year, in which the water temperature is high enough to form cyclones, is becoming longer. This is why the tropical cyclones are increasing in numbers and – due to the particularly high sea temperatures – also their intensity. In 2005 in the Atlantic Ocean there were more hurricanes than ever before since records began and no Atlantic cyclone has since been stronger than Hurricane Wilma which on 19 October 2005 reached the lowest ever measured core air pressure of 882 hPa and a wind speed of over 340 km/h.

This list is of course not complete.

3.5 degrees global warming – formulated precisely: ***A rise in global average temperatures by 3.5 degrees*** – could for example – have the following effects:

- The Arctic Ocean is completely ice-free in summer; the all-year sea ice has disappeared. The North Pole is easy to reach in summer by ship.
- Since the warming in the Polar latitudes is the strongest, the ice armour in the Antarctic and Greenland is thawing in parts. This leads, together with the heat spread of the continuingly warming seas to a rise in sea level of several metres.
- Large parts of the Netherlands, Northern Germany and Bangladesh, to name just a few examples, will be flooded by the sea if no coast protection measures are undertaken.
- Climate zones are shifting and the extent of this is not precisely known and the shift is not equally large in all regions of the earth. One example: Much has been written about the fact that the Gulf Stream will become weaker under intense global warming. In this scenario Northern and Central Europe who particularly benefit from the warm water of the Gulf Stream will cool down despite global warming.

Should there be a complete thawing of the Antarctic for which a 3.5 degrees globally ascertained temperature rise would not suffice and therefore in the 21st century is not - or not yet – anticipated, the sea level will rise by about 80 metres.

Let us also take a quick look at the climate fluctuations of the past:

In the last ten thousand years during which the human advanced civilisation developed, the climate on earth was very constant with only smaller fluctuations which are described in M10. Prior to that it was different: Over the last three million years there was a regular alternation of ice ages and warm periods. During the ice ages from time to time the whole of Scandinavia to Central Europe and half of North America was covered by ice armour up to three kilometres thick, as are the Antarctic and Greenland today. The climax of the last ice age was 18,000 years ago

and the last ice sheet disappeared from Scandinavia about 10,000 years ago.

At the peak of the last ice age the global average temperature was 6 degrees lower than today. 110,000 years ago, at the peak of the Eem warm period it was about 1 degree warmer than now. To find a time when it was significantly warmer on earth than this you have to go back more than three million years, before the start of the ice ages.

Global warming in the 21st century could therefore lead to temperatures that have not been seen on earth for at least three million years.

Task: Draw up a table in which you clearly present the different effects of more intense warming and cooling. Set up the table in such a way that you can input future scenarios into it later.

M3: Energy History, 1830 – 2005

Since the start of industrialisation the consumption of fossil energy sources has increased greatly worldwide. This can be easily seen in a graphical representation which you can generate with the EC21 software:

Task 1: Start EC21. Run the simulation of the Zero-Scenario and display the energy consumption of the fossil energy sources of coal, oil and natural gas.

Important: The values from 1830 to 2005 originate from historical data. From 2006 onwards the Zero-Scenario is assumed.

Technical tip:
- Click in Step 5 of the scenario on "more details" (see Figure 2).
- Select for example "consumption: coal" and click on "get results". The data will first of all be displayed in the table.
- Mark the desired data row in the table, click on "draw the selection" and you will obtain a graphical representation.
- Proceed in the same way with "consumption: oil" and "consumption: natural gas".
- "emission total" shows you the total emissions from fossil energy consumption.

Task 2: The consumption of fossil energy sources is closely linked to the course of world history. Show which historical events and developments are reflected in the energy consumption curves.

M4: How does EC21 calculate the climate? Part I: Alteration in the carbon cycle, CO_2 in the atmosphere

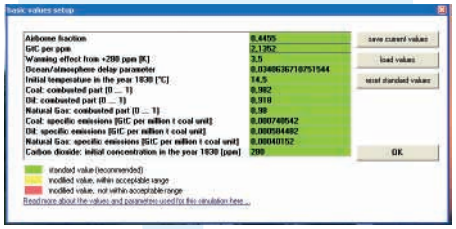
We are now making a connection between the consumption of fossil energy sources of coal, oil and natural gas and global warming since 1830 and until the end of the 21st century.

Plants grow and absorb carbon dioxide and they integrate the carbon into their biomass. In burning or decomposition after they die, CO_2 is again created from the carbon in the biomass and this escapes into the atmosphere. There is therefore a natural carbon cycle.

The deposits of coal, oil and natural gas are not part of the carbon cycle. Human beings burn coal, oil and natural gas from these deposits releasing as a result additional carbon in the form of carbon dioxide into the atmosphere. In this way humans interfere in the natural carbon cycle. EC21 calculates these changes and

their consequences for the climate.

So start EC21 and open Step 1 ("basic values setup"):



When coal, oil and natural gas are burnt, carbon dioxide occurs and in varying amounts depending on the energy source. The most carbon dioxide is created from coal, significantly less from oil and even less when burning natural gas if with these energy sources the same energy volume is generated. In Step 1 the accurate values ("specific emissions") are stated. If an energy volume of 1 million tonnes of coal units is generated from coal, then three quarters of a million tonnes of carbon is released in the form of carbon dioxide. For oil it is less and if the same energy volume is generated through the burning of natural gas, only 400,000 tonnes of carbon are released – therefore natural gas is "climate-friendlier" than coal and also oil.

Not all coal that is consumed is also burnt. It is a similar situation for natural gas and oil – primarily for oil as it is a raw material for chemical products such as plastics, drugs, adhesives, dyes and many others. Therefore in Step 1 for each energy source the proportion of total consumption that is burnt is stated: For oil it is for example 91.8%, and significantly more for coal and natural gas.

For every year between 1830 and 2005 there is data available on energy consumption which has been incorporated into the model. In this way for each of these years the volume of carbon dioxide that has been released through energy consumption can be calculated.

Figure 4: EC21 – Basic Values Setup

What happens with the CO_2 created?

Just under half of the CO_2 remains in the atmosphere. This portion is called the "Airborne Fraction". The rest disappears in what are known as CO_2-sinks for example into the water of the oceans, in which it dissolves physically, or in the forests of the earth which filter it out of the air through photosynthesis. In the simulation an Airborne Fraction of 44.55% is preset.

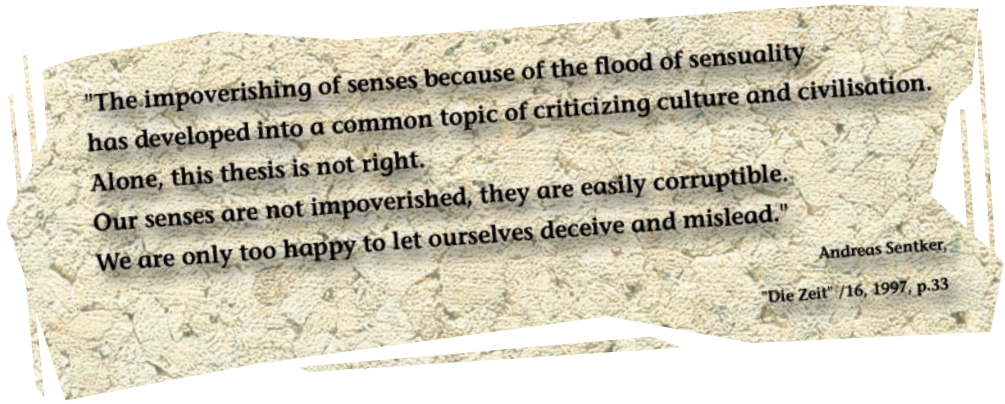
The CO_2 created disseminates evenly in the entire atmosphere. Calculations show that 2.1352 GtC, which remain as CO_2 in the atmosphere, cause the CO_2-concentration in the atmosphere to rise by 1 ppm (part per million).

Task: In 2005 7.30 GtC of carbon dioxide was released through the burning of fossil energy sources. Calculate by how much ppm the CO_2-concentration in the atmosphere would rise as a result.

If you don't feel like doing the calculation, then you can look in Step 5 at the annual increase of the CO_2 concentration as a table or graphic and there you will also find all the individual details for energy consumption under "more details".

In 1830 the CO_2 concentration of the earth's atmosphere was 280 ppm. This is preset as the starting value of the simulation.

The values calculated by the simulation for the CO_2 concentration in the atmosphere correspond well with the values actually measured.



M5: How does EC21 calculate the climate? Part II: global warming

If at this moment somewhere on the earth a huge amount of carbon dioxide were to be released through some hardly imaginable catastrophe – fortunately this is totally unrealistic, but we will just assume this for now – by how much would the global temperature change by tomorrow due to this additional CO_2? Or by next week?

The answer is very simple: Not at all or by so little it cannot be measured.

The situation would be different if we were to consider a longer period of a few years or even better a few decades: The longer we wait the more pronounced effects the additional CO_2 will have.

Why is this the case? CO_2 has a radiation effect and it absorbs infrared radiation (details on this in M1: About greenhouse gases) and as a result it becomes warmer and warmer on the earth. Initially the new CO_2 reflects infrared radiation back to the earth's surface. The earth's ground starts to warm up as does the atmosphere and with some time-lag the oceans also start to warm. If the CO_2 concentration of the atmosphere rises by 280 ppm and if one were to wait a long time – at least several decades and even better one century – the global average temperature will rise by 3.5 degrees.

In 1830 the CO_2 concentration of the atmosphere was 280 ppm. This is the start value for the simulation.

The global average temperature was then 14.5°C.

It is also known how warm it will become on the earth with a rise in the CO_2 concentration of the atmosphere, if one only waited long enough. It could be compared with turning on a radiator in a cold room in winter: At the moment of turning on the valve it is known how warm it will be in the room after a longer period of time, but shortly after turning it on the room is still as cold as it was before.

Therefore in EC21 we differentiate between the so-called theoretical temperature and the real temperature:
- The real temperature is the global average temperature which actually occurs on the earth and taking into consideration that the atmosphere, earth and oceans warm up with a certain time lag after CO_2 has been emitted into the atmosphere.

- The theoretical temperature is the global average temperature which will occur on earth after a very long time, when the atmosphere, earth and oceans have warmed up with a time lag. This time lag lasts for decades.

We assume in the simulation that half of the theoretical warming will be converted in 20 years to real warming. This value is preset in the simulation.

We have now, probably you noticed it long ago, discussed the standard settings in Step 1. You will very probably obtain the best results when you leave the pre-set values unchanged.

Should you want to change something: No problem! You can modify every entry and save your own values and then load them again later.

Modified values are highlighted in yellow provided that they are still in a meaningful range. Outside this range red background colours warn of nonsensical results.

Tasks:
1. Explain the terms "theoretical temperature" and "real temperature".
2. Explain why the earth's surface, the atmosphere and oceans only warm up with a long time lag.

M6: How does EC21 calculate the climate? Part III: fire clearances

Fire clearance of forests also contributes to the increase in the CO_2 concentration in the atmosphere. For a long time now particularly in tropical regions, forests have been irretrievably cut down and large areas of them have been burnt causing significant volumes of carbon dioxide to escape into the atmosphere.

These emissions are taken into consideration in the simulation.

Task: Start EC21. Continue to Step 2 ("forest burning setup").

Here open "individual configuration" and see how fire clearances flow into the simulation.

In the standard settings the emissions from fire clearances in 1830 were 0.1 GtC with an increase of 2.5% per year until shortly before the mid-20th century (1945) and then they remained constant at the 1945 value, namely 1.71 GtC.

It cannot remain unnoticed that we are dealing here with a certain imprecision. CO_2 emissions from fire clearances are less well known than the emissions from the consumption of fossil energy sources.

Recommendation: When you are first starting to work with this topic, you should definitely work with the standard values.

For advanced users: You can in Step 2 create your own fire clearance scenarios with different time periods and individual settings. Save your scenario and load it again later.

M7: Modelling the future 2006 – 2100 (I): World scenarios

Since approximately 1830 when the industrial revolution started to take effect, the consumption of fossil energy sources has increased hugely and thereby also has the generation of CO_2. Add to this the CO_2 emissions from the fire clearance primarily of tropical forests. This has led to an increase in the CO_2 concentration in the atmosphere from 280 ppm in 1830 to 380 ppm in 2006 and as a result the earth's climate has warmed up by about

0.7 degrees. The EC21 simulation presents both with a good level of accuracy.

Therefore we now use this simulation to represent the future.

We do not want to refrain from mentioning the limits and uncertainties of this and in fact this aspect is presented in its own section "Limits of the EC21 Climate Simulation", see below.

How warm the atmosphere will still become in the 21st century depends largely on the consumption of fossil energy sources but also on how much coal, oil and natural gas is burnt by the human race.

Forecasts of this range from the difficult to the impossible. What one can do however is to draw up scenarios.

Scenarios

A scenario is an assumption about the future. This assumption does not consider at all how likely it is that it will actually occur.

One example of this is the Zero-Scenario that is pre-set in the future simulation of EC21. "Zero-Scenario" means that we assume that the consumption of fossil energy sources from 2005 onwards will remain constant for the rest of the 21st century.

Now it is not very likely that this will actually happen. But it is interesting to compare other scenarios with the Zero-Scenario in order to see what effects any possible measures may have.

Therefore what would be the situation with the following "Zero-Scenario 2010"? The world's energy consumption continues to increase until 2010 by 3% each year for coal, oil and natural gas and afterwards it remains constant.

And a further third scenario, "Zero-Scenario 2030": Energy consumption increases by 3 % per year for all three fossil energy sources and until 2030. It then remains constant.

Task: Discuss how likely you consider the occurrence of the three scenarios to be.

With EC21 you can set up your own scenarios and simulate the CO_2 concentration in the atmosphere and also global warming. The results are displayed graphically and the calculated data can be transferred into other applications.

We have described how this happens in the following text.

Creation of your own scenarios using the example of the Zero-Scenario 2010

Start EC21. Continue to Step 3.
Our Zero-Scenario 2010 is a simple worldwide scenario, therefore select here "World Wide View".

Step 4.1:
Now state the time periods in which different things should happen. In our case we need two time periods - one from 2006 to 2010 (with increasing energy consumption) and another from 2011 (with constant energy consumption until 2100).

(Usage tip: In Step 4.1 first of all change the end of the time period to 2010. EC21 will then automatically add a further time period to it).

Figure 5: Your window in Step 4 should now look like this

Step 4.2:
In the left window you will see your two

established time periods. Select one of them and state in the right window by how many percent the energy consumption should rise or fall (use minus sign) each year. In our case it is therefore 3% for all three energy sources in the time period until 2010. When you have input all the values for the period, click below on "apply period", in order to save the data.

For the second period (from 2011) input zero everywhere as the energy consumption should stay constant. Remember to click on "apply period".

That's it! You can now continue to Step 5, start the simulation and the results will be displayed.

Task: Input the Zero-Scenario, the Zero-Scenario 2010 and Zero-Scenario 2030 one after the other and see in Step 5 each carbon dioxide concentration in the atmosphere displayed as a curve. You can close the graphic windows as you go along if you want. The three curves will be positioned one on top of the other. Just try it out!

The following tasks are best carried out as group-work.

Task:
a) From your perspective design the most likely scenario for the development of global energy consumption in the 21st century.
b) Discuss within the group what would be in favour of this very scenario occurring in the 21st century.
c) Simulate your scenario with EC21 and discuss the results within the group.
d) Cooperate with another group. Also simulate the scenario of the other group. Compare within your own group your results from a) and b) with those of the other group.
e) Sit together with the other group and compare and discuss the simulation results.

M8: Modelling the future 2006–2100 (II): Scenarios for regions

In all previous scenarios we have simply looked at the world as a whole. However, the different regions of the earth contribute in different degrees to the discharge of CO_2. Particularly North America but also the European countries produce considerably more CO_2 than Africa or South America.

How high exactly is the influence of individual countries or regions?
This can also be simulated.
Here is an example:

We create a new scenario called "Zero-Scenario 2010 USA 2020". There are three assumptions here:

- In all countries on earth the consumption of all fossil energy sources will increase by 3% per year until 2010.
- Thereafter the consumption of all energy sources will remain constant.
- Exception USA: In the USA the energy consumption will continue to increase until 2020 and also the entire time by 3% per year and for each energy source.
- Thereafter the energy consumption in the USA will also remain constant.

Start EC21, select in Regional Setup in Step 3 "One Country View". Here click first on the Region (North America) and then in the pull-down menu on "USA".

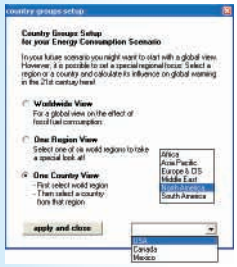


Figure 6: Country Selection

Step 4.1
Here you must now set up three time periods:

- 2006-2010 (energy consumption increase overall)
- 2011-2020 (further increase only in the USA, rest of world constant energy consumption)
- 2021 to 2100 (USA and rest of world constant energy consumption).

Step 4.2
Here you can input the development of the energy consumption for the selected region, in this case the USA and for the rest of the world.
Task: Start the simulation of this scenario and create a graphical display of the CO_2 concentration in the atmosphere. Then input the Zero-Scenario (and again create a graphical display of the CO_2 concentration in the atmosphere!) and finally do the same with the Zero-Scenario 2010. Discuss the results!

Tip for further work:
In Step 4.2 you can make your selection from six regions of the earth ("One Region View") or an individual country ("One Country View"). We do not have individual data for all the earth's countries, especially not for Africa, and therefore many countries are summarised into groups.

In one scenario separate data can be specified for one region or country (such as the USA as in the example above) and for the rest of the world (without this region or this country).

An individual combination of countries and regions is not yet possible.

M9: Modelling the future 2006-2100 (III): An example: the Kyoto Protocol

What are the implications of the Kyoto Protocol on global warming?
The Kyoto Protocol which was passed in 1997 at a UN climate conference in Kyoto in Japan specifies that carbon dioxide emissions should be reduced worldwide by an average of 5.2% between 1990 and 2012. It came into force on 16 February 2005. By that time 141 countries covering 85% of the world population and who between them generate 62% of the global CO_2 discharge had ratified the Protocol.

A reduction of a total of 5.2% over 22 years corresponds to an average reduction of about 0.25% per year.

Task: Scenario "Extended Kyoto"
Assume that all countries in the world will adhere to the Kyoto Protocol as from 2006 and that they will therefore reduce their CO_2 emissions year on year by 0.25%. Also assume that all countries in the world would continue to do this until 2100 after the end of the contractual period in 2012.

Simulate the scenario "Extended Kyoto". Compare the CO_2 concentration of the atmosphere and the global average temperature (i.e. the real temperature) in the years 2030, 2050 and 2100 with the Zero-Scenario.

Another scenario: "Business as usual I".
In this scenario we simply assume that everything will continue as before, therefore "Business as usual":

Despite the Kyoto Protocol the

consumption of fossil energy sources over the last few years has continued to rise even in countries which have signed the Kyoto Protocol.

Between 1990 and 2005 the worldwide average increase was for:

- Coal consumption 1.68 % per year.
- Oil consumption 1.31 % per year.
- Natural gas consumption 2.14 % per year.

In the scenario "Business as usual I" it is simply assumed that the average development of the last thirteen years will continue until 2100.

Scenario "Business as usual II"
Now let's take not the last fifteen years but the last five years:

Between 2000 and 2005 the worldwide average increase was for:

- Coal consumption 6.06 % per year.
- Oil consumption 1.60 % per year.
- Natural gas consumption 2.36 % per year.

The 6.06 % is not an error. Over the last five years coal consumption has increased hugely in some developing countries.

Task: Simulate the two "Business-as-usual" scenarios.

- Compare the resulting energy consumption in the years 2050 and 2100. (For this consult Step 5 under the button "more details".)
- Compare the CO_2 concentration and real temperature with other scenarios!
- Discuss the results.

We have now described the most important things that you must know in order to carry out meaningful simulations of global warming in the 21st century with EC21. Set up other scenarios and compare them!

If you want to discuss the results it is a good idea to also read the following chapter.

M10: Limits of the EC21 Climate Simulation

How accurate are the results of the EC21 simulations - or what can't EC21 do?
EC21 simulates the future based on the past. This permits meaningful statements about global warming in the 21st century which in the end depends on how the consumption of fossil energy sources develops in this period. Precisely in this connection EC21 delivers tangible, specific results since the software ascertains a global average temperature for each year.

Not only CO_2 increases the greenhouse effect.

Other gases even in very small concentrations can also have a strong effect on the climate in a similar way to carbon dioxide. These gases include water vapour, methane, chlorofluorocarbons and nitrous oxide. The concentrations of these climate-effecting gases in the atmosphere are increasing and this could cause an additional warming effect. EC21 only considers carbon dioxide.

Feedback Effects.
The majority of the Arctic Ocean is covered the entire year with sea ice that is only a few metres thick. Due to global warming more and more ice is melting and the surfaces of the Arctic Ocean still covered with ice at the end of the summer are shrinking from year to year. Where there used to be ice the whole year which largely reflects

the solar radiation, there is now open water for months every year. This open water predominantly absorbs the solar radiation rather than reflecting it. As a result the Arctic Ocean, and by extension the atmosphere, warms up even more. This effect is an example of a positive feedback: global warming leads to additional warming.

There are other positive and also negative feedbacks in the earth's climate system. One only has to think of the expected change in ocean currents, for example the Gulf Stream, the possible shift of climate zones and much more. EC21 does not take these into consideration.

How warm will it be in 2050 in ... ?
EC21 calculates a global average temperature; however it does not allow any statements on individual places or even broader regions of the earth. Even very complex climate simulations have difficulties with such questions. The warming will not be of the same intensity everywhere. It will probably be more intense in the high geographical latitudes than in the tropics and it is even possible that there will be areas where it will be cooler in the future than previously. Some climate scientists fear this for Northern and Central Europe should the Gulf Stream diminish.

Natural Climate Fluctuations
Over the last three million years there has been a two-digit succession of ice ages and warm periods and also after the end of the last ice age 10,000 years ago there were – less distinct – natural climate fluctuations:

- Over a thousand years ago in a particularly warm climate phase the Vikings settled on a large island north-west of Europe which they named "Grønland" or in English "Greenland". In today's climate conditions this settlement could not have taken place.
- In the 16th and 17th centuries Europe experienced a cold climate phase which today is referred to as the "Little Ice Age". Famous from this period is the fair on the frozen River Thames in London in winter 1607. It is certain that such climate fluctuations will also occur in the future.

EC21 does not consider such natural climate fluctuations.

The list of limitations is not complete. To sum up it could perhaps be expressed as follows: Based on historical data and on a whole series of assumptions, EC21 calculates the carbon dioxide discharge and the global warming effect of energy consumption scenarios in the 21st century.

All assumptions and data can be and must be modified and further developed.

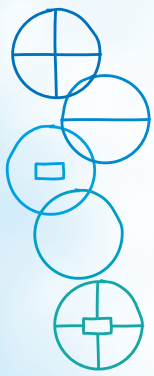
Whether the warming effect described by EC21 will occur in this way or whether it will be strengthened or weakened by other influences (keyword: feedbacks), it is not possible to say.

All climate simulations, even the most up-to-date available today, are subject to the trends of these or similar limitations.

Nevertheless our comparatively simple model delivers very usable, meaningful results. For the past this is proven and for the future this can be anticipated for a good reason.

And therefore it's worthwhile working with it!

Enjoy it!!!



M11: Further actions – what remains to be done?

A software application such as Energy and Climate 21 will never be finished. It is revised by us at irregular intervals, for example by updating the historical energy consumption data. New functions and programme features are also in planning and we will see what we will be implementing from this.

The latest version of the software is always available at http://www.agenda21now.org/ec21.

Energy and Climate 21 is free software and falls under the GNU General Public License (GPL).

You may use the programme without limitations and for every purpose, make copies of it and distribute it as long as the source code is also distributed with it. All copies are also subject, with no restrictions, to the GNU GPL.

You may read and modify the source code and forward modified versions of the programme, however under one condition: All derived programme versions, even parts thereof, are also exclusively subject to the GNU-GPL. Any commercial usage is prohibited.

If you create a revised programme version, please inform us.

Conclusions

A lot has been said in this article – by those of us who have written this article, and maybe also by you, if you have worked with the tasks.

What is left to do? What can we do? What can I do?
One of the earlier books in the Baltic Sea Project Learners' Guides series is called: "From Words to Action".

After so much talk, it is finally time for action. Don't you agree?

Tasks:
(Suggestion: Carry out tasks 1-4 in groups, and 5 and 6 all together as a conclusion)

1. Create a scenario whereby the actual temperature in the 21st century increases by no more than two degrees (therefore to 16.5°C maximum). The scenario should be as realistic as possible.

2. In your group, discuss why you consider this scenario to be realistic.

3. What measures do you consider useful/necessary in order to achieve the goal (maximum 2 degrees warming)?

4. What can I myself do so that the goal can be achieved?

5. Presentation: the work groups present the results of 1 to 4.

6. Final discussion: Discussion of measures (tasks 3 and 4) in plenum.

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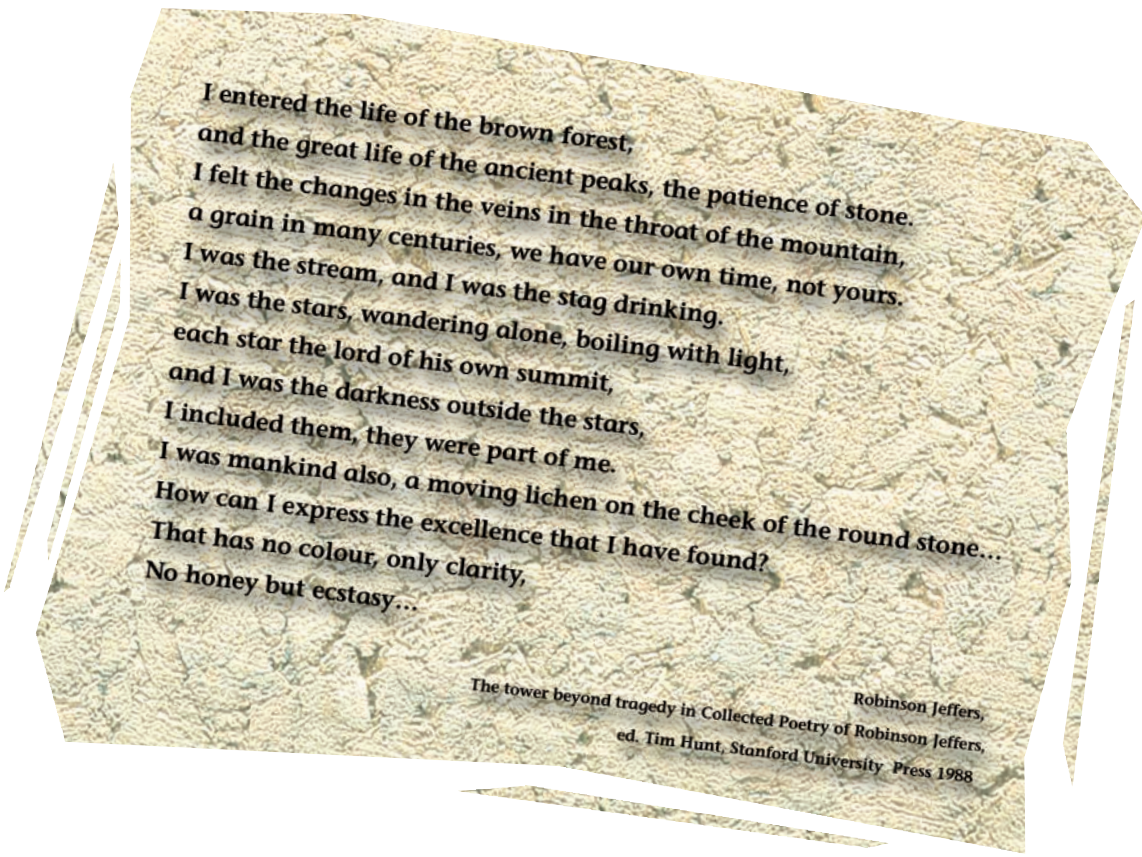
On the BSP Learners' Guide 7 website:
More about climate change and Climate 21
http://www.b-s-p.org/lg7/climate21



A Can and a Bottle – Which one has the Future?

by Stanislav Babitch, Elena Bogacheva, Natalya Elmanova, Marina Fedorova, Evgenia Ivanova

Beer! An important part of human culture, dating from the times of the Ancient Egypt, and definitely an important part of the life of people in our city. Don't worry; this article is not about encouraging you to drink beer! Actually we are not keen on beer ourselves, but we have noticed some things about beer that we find interesting and somewhat paradoxical! For example:

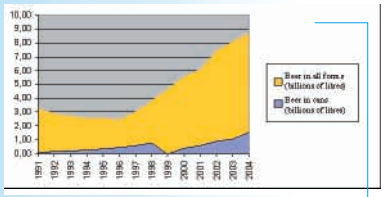
- Advertisements for beer seem to be the most frequent and most creative advertisements on evening TV;
- We live in Saint-Petersburg, where the most successful Russian beer producer is located;
- Canned beer and other can beverages are vigorously promoted on Russian TV. In contrast canned beverages seem to be less promoted and sold in Europe;
- Beer and other low-alcohol and non-alcohol drinks are becoming more and more popular competing with vodka from alcohol market.

Russia has a rich tradition of brewing. We started to brew beer as long ago as in times of Peter the Great (more than 300 years ago) and even before the foundation of Saint-Petersburg. Peter the Great and Catherine the Second (Great) invited experts in brewing from Britain, Netherlands, Latvia and Germany. There is a brewery in Saint-Petersburg, which was founded in 1795 under Catherine the Second (Great) and has been producing beer till now using old technologies of brewing. The modern technology used for making beer has not really changed that much during the times, the biggest changes have occurred in the way beer is packaged and distributed. Only the packaging has been developed strongly and that has allowed beer to conquer new lifetimes and territories. In USSR times beer and some other beverages like kvass (a traditional Russian beverage) were available in only one type of package - big yellow barrels, called kegs. It was poured out to people right on the street and was delicious and fresh even though it didn't have a shelf life of more than a few days. It was drunk before it spoiled.

In the early 1990s customers having been used to having beer from kegs were presented with much more choice. As the economy developed towards a more open economic system and new products became available such as canned beverages, consumption of canned beer grew by 30% per year reaching a peak in 1997 of 1.2 billion cans sold across Russia. People would buy any drink it seems providing that it was in cans. Brightly decorated cans became part of the fashion and to drink beer from a can was seen to be really "smart".

In 1998 the canned drink market plummeted to only one third of its former size at 400 million cans consumed that year. The drop was caused by the devaluing of the rouble that year which fell by 300% compared to dollar.

This affected the production cost of cans more than both glass bottles and plastic containers and the result was that in comparison a can of beer doubled in price. Another influence on this drop of sales may have been consumer resistance as people became disillusioned with the quality of beer in cans due to problems with manufacturing and distribution. In the



Can beer share in beer consumption between 1991 and 2000 in Russia The diagram is based on yearly reports of largest breweries (Baltika f.e.)
This graphic was made by our team on the basis of the Baltic company official data.

early days no one really paid attention to quality of the product and consequently it was not uncommon for people to buy cans that had been sitting around for months, were tainted with the taste of preservatives or simply spoilt.

Despite these setbacks, beer continues to be an important part of the domestic scene and in 2000-2004 the brewing industry was growing by 20% per year and canned beer sales were again on the increase.

Implications of the changes

Changes in consumer behaviour, the way people buy their beer and other goods has implications on the environment. Packaging materials need to protect the product from damage, in the case of beer preserve the drink's taste, until it is purchased and aid in the products shipping, purchasing and consumption. The final consideration for the packaging chosen is that it becomes waste after its contents are consumed. A change in consumer behaviour can have large effects on the waste stream produced.

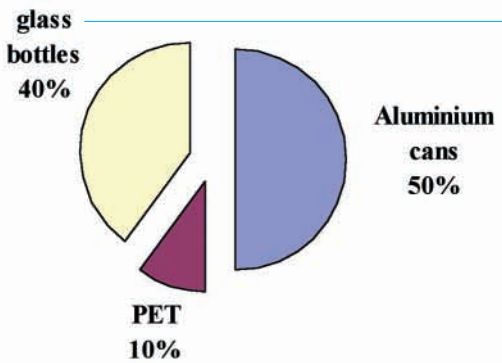
The current situation in Russia is that of all the drinks that are sold around just under half are in Aluminium cans, another similar proportion are in glass bottles and the remaining 10% are in PET (poly-ethylene terephthalate) plastic containers.

On world statistics, cans seem to be the most popular packaging option for beer and other beverages with around 240 billion drink cans produced annually. The biggest producer is the USA followed by Japan, Brazil and China. In Europe 47 Billion drink cans are produced and their contents consumed every year.

Different types of aluminium cans (tin cans for drinks are not produced and sold in Russia). All photos in this article: private

The market share of beverages packaged in cans in Europe has increased over the last decade and now around 50% of all beverages being consumed from cans. The market share for beer in cans has risen to 25% over the same period with the most dramatic increases seen in Eastern Europe.

According to Euromonitor.com, glass bottles are the other dominating type of container for drinks in Russia (51 % of the market) with 8-10 billion bottles sold per year. Estimates predict that by 2008 the demand will exceed 12 billion, a growth of about 20%.



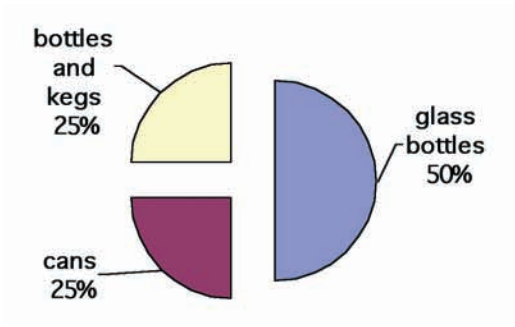
Beverage Packaging in Russia (This graphic was made by our team on the basis of the Baltic company official data)

Can and Bottle

Different types of Russian glass bottles

Plastic (PET) packaging has received wide recognition over the last years and forecasts predict that its share in the world beverage packaging market will be around 30 % by 2006. It is estimated that by 2006 up to 5 % of the total amount of beer in the world will be packaged in PET-bottles.

The situation in Russia with beer production is that around 50% of all beer is packaged in glass bottles, around 25% in cans and the remaining 25% in PET bottles and kegs.



Beer Packaging in Russia
(This graphic was made by our team on the basis of the Baltic company official data)

Responses

The recycling of the packaging material used for drinks is one response that can be made to minimize the environmental effects of our changing consumer behavior. Cans, bottles and PET containers all have different issues to consider with their recycling.

1. Glass recycling

Glass bottles are a type of returnable container that can be used more than once if they are in good condition with some breweries using up to 80-90 % of recycled bottles, returned empty containers. The recycling process can be as simple as cleaning and disinfecting. This secondary use of glass bottles is a traditional one in Russia and also the most developed in our country. Some of the factors which help this situation are the cheapness of the returnable container, the refund given for the empty bottles (about 5 eurocents per bottle), the established tradition of returning the bottles and the developed network of bottle collection places, which have remained since Soviet times (before 1991) and where anyone can bring used glass bottles and receive the refund for them.

Different (the most popular in Russia) types of plastic bottles

2. Plastic recycling

Unlike in the past where plastic containers were often sent to landfill, nowadays almost all plastic waste is able to be recycled. New technologies for processing and secondary use of PET plastic and other plastic materials have been developed in the last years. As a result PET packaging is capable of being repeatedly recycled into new products. Recovered PET is first sorted into different colours (clear, green and amber). The sorted material is commonly baled for transport to a reclaiming processor where a shredder hacks the material into flakes, which are washed, and the contaminants removed in a flotation process. The dried flakes are re-granulated and become the raw material for manufacture into new products. The highest quality flakes can be used in the remanufacture of bottles and plastic sheeting. Because food packaging regulations have requirements which cover the use of post-consumer materials for food packaging, reclaimed PET is more likely to be used in other products that require lower quality inputs, such as fibres. Recycling into fibre is a low end application and pays less than bottle and sheet grade however. As technologies improve "Bottle to bottle" recycling is, however, increasing.

3. Aluminium recycling

Aluminium cans may be fully recycled. After collection they are melted in an inclined furnace and remade into aluminium sheeting and then reformed back into cans. The re-smelting of aluminium is however energy expensive and potentially hazardous to the environment. Modern technology is now available and being used by eco-engineering companies such as Rostar-Holding in Russia which has the first large scale aluminium recycling facility near Moscow which along with others is certificated according to the international quality standard ISO 9002. The biggest issue in aluminium can recycling currently in Russia is the low level of return by consumers.

Recycling systems and recycling behaviour

In many countries there are quite successful recycling systems with two main approaches. One of them is known as the German model, which was created by the DSD organization (Duales System Deutschland GmbH), which focuses on gathering and recycling of used packing materials. In this system the costs of recycling of packaging materials like glass, plastic and aluminium are paid for by the manufacturers of the packing and goods which use this packaging. The cost is inevitably included in the cost of the product and is passed on to the consumer in the price of the goods.

The German system was the first system to collect packaging waste separated from household waste as well (the dual system). In all cities of Germany there are the usual garbage containers for municipal waste products, and as well as these a second, yellow garbage container in which it is possible to throw only waste products of the packing materials indicated. They are designated at a set location, the green point.

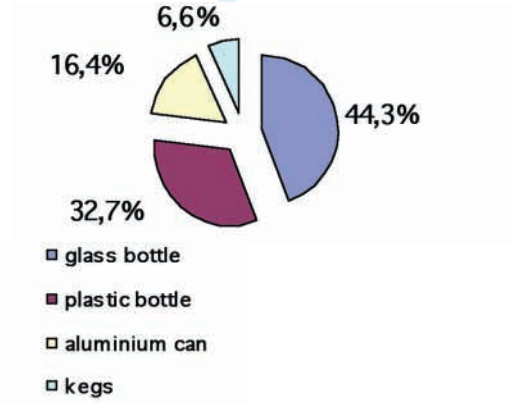
The other system which operates in Denmark works on a mortgage concept. For example consumers pay an extra 18 cents for each aluminium can produced in Denmark and receive this money back at delivery of the used containers. The system only works however for cans produced and sold in Denmark.

Can an Bottle

An innovation on this system has been the development of automatic machines designed for the collection of plastic bottles and metal cans which have already been established in Moscow (2004). The bar code on the product is read as it passes into the machine and its "Fondomat", the code that defines the category of the object is identified and the machine gives out money for it. Already approximately 3 % of Moscow's waste for such categories passes through these automatic machines. The machines are colour coded to help people put articles in the right holes. Dark blue for plastic bottles, red for cans. The bottles and cans are partially processed inside the machine and flattened for storage. Each machine is capable of collecting about 3,000 cans and bottles before needing to be emptied.

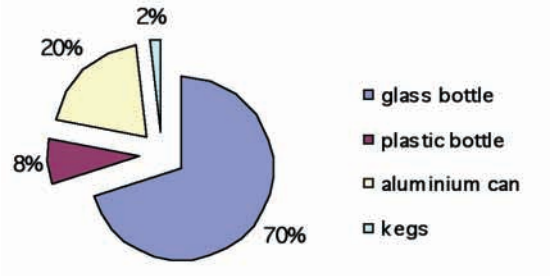
Official statistics (according to the Government statistic committee) about what kind of drink's packaging is considered to be the friendliest to the environment and the most preferable by Russian consumers shows:

- glass bottle – 44.3%
- plastic bottle – 32.7%
- aluminium can – 16.4%
- kegs – 6.6%



We designed a questionnaire to investigate which packaging people prefer in our own community to compare with the national averages. We surveyed members of our families, work colleagues and university students, about 400 people in total. The results show a different situation to the national average.

- glass bottle – 70 %
- aluminium can – 20 %
- plastic bottle – 8 %
- kegs – 2 %



A personal perspective

Comparing the findings of the two questionnaires we can see that our community has a different behaviour than the national average. Beer in glass bottles has a much higher representation at the cost of plastic bottles, but cans are about the same as the national average. It is interesting to wonder about the reasons for the difference. Perhaps a population with a lower average income drinks more beer from plastic bottles?

Conclusion

Packaging of beverages and beer in particular in this study has an impact on our environment. Of the three main packaging materials aluminium cans and plastic bottles are increasing in market share and the situation in Russia is following the same trends as in the rest of the world. These

changes in consumer behaviour are having effects on the environment as the different packaging materials have different recycling behaviours and the potential to recycle materials is changing as new technologies are developed. Thus, the question should be not: a can or a bottle, which one is better, but: do we recycle packaging or not? The majority of the developed countries (for example Germany) confidently answer "recycle". And it is to what other countries, including Russia, should aspire to. However we still have a number of unresolved problems on a way to it. And the main ones are:

- The development of legislation concerning waste recycling and the absence of the state support for the programme.
- Education and awareness for the majority of the population that does not realize the importance of their own behavioural decision as part of the problem and of the solution.

And then just some puzzling questions:

- Why do our automatic recycling collection machines flatten cans and yet the Danish ones do not accept deformed cans?
- Why in the Danish system is the refund for cans set at 0.18 euros per can and in our system run on the same ideas is the refund for a can 0.006 euros? If the technology used is the same and our equipment is constructed on the European technologies then why not the same refund?

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Increase Focus on Energy Issues in School

by Per Ericson

It's in the middle of the Friday rush at the big shopping centre. The students of the winning team are smiling. After many hours of hard work they have just won the final of The School Competition on Energy in Nacka 2004.

The way we use energy today is not sustainable. Global warming and other severe environmental problems are connected to energy use. How can we set the energy issues in focus at school and educate students to become conscious and smart energy users?

In 2004 some schools in Nacka, a community 20 km outside Sweden's capital Stockholm, organized a competition on energy for students, 13-16 years old. The inspiration came from the organization PEAK in California, US. This article tells about the competition as a way to focus schoolwork on energy.

Energy concerns everybody every day. Energy id defined as "the ability to do work". It is everywhere, all the time. It is neither created nor destroyed – it simply changes its form. When you burn a log the chemical energy of the log converts to light and heat. All events in nature include energy. To learn about energy is to learn about the world.

The development of our modern society was based on a growing use of energy, mainly from coal and oil. The average Swede uses more energy than the average European. We use energy for transports, in the industry, in electrical equipment in our homes and for many other things. Since the year 1900 energy use in the world has multiplied 10 times, and it is still increasing. At the same time the supplies of fossil fuels are running out, maybe in 100 years from today. The use of fossil fuels contributes to climate change through increasing global warming and to acidification of many lakes. It also makes the air unhealthy in many cities of the world.

In Sweden most of the energy is used in the industry, for transports and in buildings. Less than half of the energy in Sweden comes from fossil fuels, but Swedes use more energy than the average in Europe. Our climate is cold and much energy is needed to warm houses. Despite of modern energy efficient electrical appliances the consumption of energy in our homes increases. The Swedish Energy Authority thinks that there is a large potential for savings.

You make choices every day that effect the environment and the future. Do you choose the glittering apple from another part of the world in the shop? Do you use the remote control to turn off the TV and leave it in a standby position still consuming electrical energy? Do you go by bicycle, bus or car to work or to school?

There certainly are many reasons to focus on energy and energy use in school.

Why compete?

All Swedish upper secondary schools teach about energy. The curriculum demands that all students have knowledge of energy matters. That doesn't mean that all young people are aware of the need for energy savings. "I don't care!" is a common attitude to the international environmental question that seems to lie far from everyday life. So how do we get more commitment and more focus on issues of energy use in schools?

In spring 2004 some science teachers in Nacka came up with the idea of a competition between teams in different schools.

(Photo by Per Ericson)

Class 9e2 working on the exhibition (Photo by Per Ericson)

Class 9e3 recording a scene in their film "The Energy Villain and the Energy Man" (Photo by Per Ericson)

The time is 8 pm on a Friday night, 6 hours after the finish of the official working week. They look tired, but they will keep on writing on their essay, because the deadline draws close, so they have to send the essay to the jury tonight. (Photo by Per Ericson)

The excitement of a competition could lead to more motivation. We named the competition "Who cares!?" It was meant to create interest and questions. Thanks to support from the community of Nacka we could offer a first prize of 9,000 Swedish Kronor (approximately 1,000 euros) to the winning team.

Many rules, and yet much freedom

We invited students of ages from 13-16 years (upper secondary school) in Nacka to compete. About 20 teams entered the competition.

The logo of the competition

The teams had to answer three questions: Why save energy? How can you save energy? How influence others to save?

The answers were to be given in the forms of an essay, an exhibition and an oral presentation.

With this challenge we wanted to encourage creativity and different solutions. To classify the contributions in a fair way we needed explicit criteria. Here are some of the most important rules and criteria.

Rules

- A team consists of a group of students all at the same school and in grade 7-9.
- Three members of the team make the oral presentation.
- The team should cooperate during all of the competition.
- The work must be done by the students. The teachers should inspire, encourage and guide.
- The essay should consist of about 1,000 words.
- The area of the exhibition is limited.
- The exhibition can be composed of models, pictures, texts, films etc. Only the area and your fantasy set the limit.
- The oral presentation can be, at a maximum, 10 minutes.

Criteria

Exhibition

- Does the exhibition carry the students' ideas forward in an informative way? 1-5 p
- Is the exhibition attractive? 1-5 p
- Is the perspective of the future visible? 1-5 p
- How well does the exhibition answer the three questions of the competition? 1-5 p / question

Essay

- How captivating is the essay and how is the language quality? 1-5 p
- How much does the essay rely on scientific knowledge on energy and energy management? 1-5 p
- Are there some innovative ideas on future energy management, sources of energy and new ways of influencing others? 1-5 p
- How well does the essay answer the three questions of the competition? 1-5 p / question

Oral presentation

- Is the presentation attractive, informative and coherent? 1-5 p
- How well does the team answer different questions? 1-5 p
- How well does the team cooperate during the presentation? 1-5 p
- How well does the oral presentation answer the three questions of the competition? 1-5 p / question

A long and winding road to the final

The students were to come up with the ideas, find the facts, do the work and co-operate to put it all together. My role as a teacher became to help the students to organise work, give feedback and to get them different things they needed. Sometimes progress was slow, and sometimes creativity flowed. Because it was a competition the teams constantly tried to improve every detail as the day of the final got closer.

The final – excitement and many interesting ideas

In the morning of Friday, November 12th, 2004 six teams arrived to Forum Nacka, the big shopping centre. They arranged the exhibitions and started to rehearse the oral presentations waiting for the jury. Curious shoppers went by asking about what was going on.

The essays and exhibitions were filled with interesting facts and creative ideas. The readers were surprised to learn that in the community of Nacka, with 78,000 inhabitants, the cost of having electrical equipment like TVs and computers in the standby mode could be estimated to about 1 million Euro every year. (There are other examples of the power of mathematics to make you aware of how small energy choices every day matter in the long run at the end of this article.) The visitor could try a quiz to win a CFL (compact fluorescent light), try different experiments and find out about his energy habits. A model of a fuel cell car was on display and a team showed a film they had made where the Swedish Minister of Energy participated.

The jury decides on a winner

In the jury there were teachers, energy officials from Nacka, a scientific journalist and older students. They had already given their points for the essays and today they judged the exhibitions and the oral presentations. One of the teams made a TV-show were the audience asked questions via a computer. The old Swedish comic strip characters "Miss Save" and "Miss Waste" appeared in another presentation.

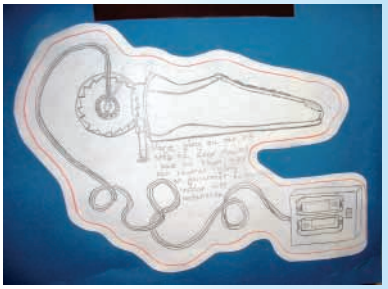
After an almost unbearable waiting during the addition of the points it was time for the prize ceremony. The class 9e2 won 1,000 Euro and the other teams 100 Euro each. All of the teams had won new knowledge and experience.

Conclusions

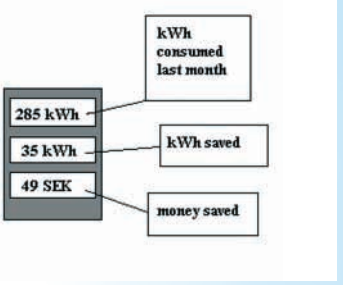
For me the best thing about the competition was the engagement and creativity that was released. Students were motivated by the new audience. It is a completely different thing to make a presentation to a jury consisting of people you don't know instead of to your usual classmates.

Teachers and students got to meet people from other schools. The hard work had many memorable episodes and got my class closer together. The teams were proud to have succeeded the task together. Students learned about energy and energy use, but the project also resulted in more general experiences and knowledge. They were practising cooperation and presenting ones ideas in a way that is attractive and easy to understand.

Schools need help to organise the competition. I believe that communities and organisations have a lot to gain by arranging this type of projects together with schools. Why not "Best Energy Saving School of the Year"? It could be possible as in the PEAK project to engage students and their families together, so that a smarter energy use starts to spread in society. The work will go on in Nacka.



This shows an idea of a seventh grader, the shoe has a generator which is charging two batteries as you walk. (Photo by Per Ericson)



The new electrical meter from 9e2 that will make people save energy and money (Picture by 9e2, translated into English by Per Ericson)

"Miss Save", "Miss Waste" and the "Professor" tell the jury about smart energy use. (Photo by Per Ericson)

What is PEAK?

PEAK was developed by John B. Phillips as an answer to the oil crisis in California in the 1970s. The name PEAK is the peaks in energy use that occur every day in California and have some times led to blackouts. PEAK is an organisation which supports education on energy in a large number of schools in the US. PEAK also consists of a curriculum and material for teaching on energy. One of the goals of PEAK is to educate young people to smart energy users and make them influence their families towards more sustainable energy use. Nacka has cooperated with PEAK for about 10 years. You can read more about PEAK and smart energy use at their web site www.peakstudents.org. It contains facts, quizzes and a simulation programme that allows you to test the energy consumption in your home. There is also information on the website of The Energy Coalition, www.energycoalition.org.

You can use mathematics to make people aware of the importance of small every day choices. Teachers/students could construct tasks like this from local conditions involving energy consuming equipment.

The shower

It's nice to take a shower. Some of us like to shower for a long time. With an old nozzle a shower will spread about 12 liters of water per minute. A modern water saving nozzle can reduce the amount of water by 50 %.

1. How much energy do you consume in the shower each year? Maybe you could measure how much the shower at your home spreads each minute.
2. Try to calculate the savings in energy and money your family could make if you changed your nozzle and shortened the time in the shower?
3. What about the potential of saving in your country? In Sweden there are about 4 million households.

The CFL (compact flourescent light) or "low energy lamp"

Get a CFL (11W) to compare with an ordinary light bulb (60 W). There is a lot of information on the packages.

1. How much energy and money can you save under the life span of the CFL if you switch from an ordinary light bulb?
2. How much energy can be saved in Sweden in a year if every household switched two ordinary light bulbs to CFLs?

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The forests are silent
The seasons rove through the forests.
Man does not see it. Man only reads about it in papers.
The seasons roam through the fields.
Man counts the days. And man counts the money.
Man longs for escape from the hustle and bustle of the city.

The sea of rooftops crashes like brick-red waves.
The air is thick and as if of grey cloth.
Man dreams of fields and of horse stalls.
Man dreams of ponds and trout.
And would like to visit the still.

The soul becomes stooped from concrete walking
With trees, man can speak as if with brothers
And exchange your soul with theirs.
The forests are silent. But they are not still.
Anyone who wants to come; they cheer up everyone.

Man flees the offices and factories
It doesn't matter to where! The earth is round, after all.
There where the grass nods like an old friend
and where the spiders knit silky stockings
There, man will be healthy...

Gerda Gollwitzer, Botschaft der Bäume,
DuMont Cologne 1984, p.74

Chapter 4: RE-VIEW

"We can be confident that action which is in accord with a few basic beliefs cannot be wrong and can at least testify to the values we will need to cultivate. These are the beliefs that the human race is a family that has inherited a place on the earth in common, that its members have an obligation to work toward sharing it so that none is deprived of the elementary needs for life, and that all have a responsibility to leave it undegraded for those who follow."

Gilbert F. White, "Stewardship of the Earth", Geography, Resources, and Environment: Selected Writings of Gilbert F. White, Volume 1 1986

The History of Recycling

by Bernd-Stefan Grewe

Some historians have described the economic system of 18th century as an "advanced organic economy". The basis of this system was the use of land, it was an organic system. Land was the source of food, energy, construction materials and raw materials for industry. The economy was based upon textiles produced from animal and vegetable fibres, leather from animal hides, wood for fuel and building. The possibilities of growth were limited, because industrial growth would place increased demands on the land to provide fodder for horses or wood for building, domestic fuel, and charcoal to produce iron, potash for glass production and textile industry. Everybody was aware that there were limits of economic growth within this organic system. The pre-industrial technology was not able to pass these limits, but in some cases to use the existing resources in a more efficient way.

The energy needs of the economy were largely supplied by a flow from food crops and wood, supplemented by water and wind power, which could not easily be increased. Any temptation to cut more wood than the annual growth would run into problems as reserves were exhausted; the use of more land to grow vegetable raw materials would collide with demands

The History of Recycling

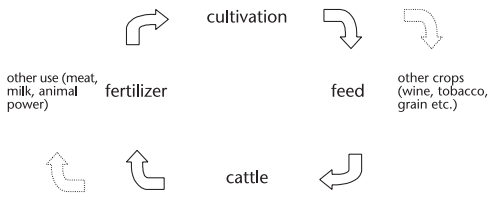
for food. As the productive land was limited, the possibilities of growth in an organic economy were therefore limited, too, until restraints were removed by the injection of massive amounts of mineral fuel (coal) and of chemical fertilizer which did not come until the mid 19th century. The economy of the 18th century had problems to supply their demand of energy and raw material, the production was limited by a shortage of fuel and material resources. How did they manage to organize the needed resources if they were in short supply?

"The golden age of recycling"

Many people in pre-industrial Europe were poor. Their poverty forced people to reduce waste to minimum, and durable goods were continually re-used. People did not only avoid waste, materials were also recycled whenever possible. Few goods were lightly abandoned; fewer still were left to rot by the roadside. Nearly all items discarded by one person could be used by another in unaltered form, in a repaired or partially reconstructed state, or in a totally new guise after recycling. It is impossible to quantify, but there can be little doubt that the recycling of material was of high significance to the pre-industrial economy. The following four examples may illustrate how often things were recycled in pre-industrial time.

Recycling in agriculture

The whole of agriculture consisted of a vast, interlocking productive system. The fields and meadows produced food and fodder for men and animals. The excrements of the cattle were needed as fertilizer to maintain and to raise the fertility of the ground. If fertilizer was brought on the fields, a higher harvest could be obtained. The better the fodder for the cattle, the better was also the fertilizer and the higher a harvest could be. This was the typical cycle of production in pre-industrial agriculture:



This agricultural system could be taken to mean that pre-industrial peasants lived in a prefect harmony with nature. But there is also another side of the coin. The agricultural production depended very much on the weather. If spring and summer were rainy and cold, both harvests could be very bad. The peasants then missed not only the cereals, but also the fodder to stable beast in winter. So they had to slaughter most of the cattle and pigs before winter and in the next year they were short of fertilizer which meant again a lower harvest than in good years. So one bad season could have strong effects in the following years, it was never a single event. Men and their beast were often starving. The cycle of production could quickly turn into a vicious circle. The following table shows how often people in pre-industrial Europe have starved.

Considering how frequent starvation was in Central Europe, one may judge the cycle of agricultural production also in a different way. Everybody but a few wealthy people was concerned by these hunger periods. A case to illustrate this context was

Years of hunger in Central Europe 1680 – 1817

1660 – 1663	
1691 – 1693	
1698 – 1699	
1709 – 1712	
1724 – 1725	
1739 – 1741	Famine
1755 – 1757	
1760 – 1762	
1766 – 1768	
1770 – 1772	Famine
1780 – 1784	
1787 – 1790	
1793 – 1795	
1799 – 1800	
1805 – 1807	
1816/1817	

(Wilhelm Abel: Massenarmut und Hungerkrisen im vorindustriellen Europa, Hamburg u. Berlin 1974)

the cattle. During life they had to pull the ploughs and carriages, they provided milk (cream, butter, cheese) and dung to maintain the productivity of the soil. After death they gave meat, skins, tallow and glue. Horns and hoofs were used to cook glue, the bigger horns were sold to trades that produced combs, but grinded horns were also used as a fertilizer; the hair was needed to make felt and felt hats; the skin was given to the tannery to make leather; tallow was needed to make soap or candles.

Few things were thrown away in agriculture. Pigs fed the left-over of the cooking and even the dishwater was re-used in order to cook fodder for the beast. The cultivation of grain produced also a lot of straw that was often used as thatch for the roof, to make chairs and baskets. But straw was more important to absorb the excrements of the beast and to produce manure (dung).

And what happened to the excrements of men? Excrements being regarded as a nuisance in certain places at certain times, but the collection of human excrements was regulated in village and towns. Night soil was considered a resource of considerable value. As can be seen in agricultural literature, human faeces as well as that of animals had previously considered to be a fertilizer. Dung collectors, night-soil collectors and the like were common in pre-modern cities.

Stinking Bremen in 1852. Buckets with faeces were collected at noon, but had to be put in front of the houses early in the morning. (Heinrich Erhard Collection, beim Umweltbundesamt Berlin)

A lot of human urine was needed for textile industry. It happened to some people that they were invited to have a beer in order to obtain their urine afterwards. In garrison towns the content of the latrines and of the stables was frequently sold as dung to framers or gardeners. Through the provision of night soil, men, women, and children could join the ever-turning cycle of production in agriculture which was so central to the life of pre-industrial societies. In times of plague, this practice was forbidden in order not to spread the epidemic.

Recycling of metals

Most metals could be, and were, recycled. This was obviously the case with precious metals; coins were called in and reminted from time to time. Base metals – such as lead, pewter and iron – were also recycled. Metal artefacts were not always reduced to their primary materials before re-use. Many metal wares were long lasting and passed from generation to generation. Their longevity could be increased by judicious patching; blacksmiths were frequently put to work by the people to repair their warming pans, the fire-grates (fireplaces), the jacks for cooking or the tea-kettles ("my kettle with a hole"/"Ein Loch ist im Eimer"). Lead, with its low melting point, was the most easily recycled of all metals. Glaziers needed it to fix the glass; plumbers to construct water-pipes in buildings or for church roofs. But not all lead survived for recycling: some was consumed in the production of silver and copper, and lead was used as an ingredient in a number of products – paint, glass, pottery, and, with occasional devastating consequences, ladies' make-up (with a poisoning effect).

The History of Recycling

Pewter, an alloy predominantly of tin, with some lead and other minerals added, was another frequently re-used metal. Recycling of kitchen vessels, of pewter mugs and dishes has been so common that today it is difficult to find early specimens of pewterware. In the pewter crafts recycled materials were responsible for over half the new items coming on to the market.

Brass, copper, and bell-metal – an alloy of copper and tin – were also eminently suitable for recycling. Once again it was seldom necessary to do more than melt down the scraps of metal and recast it.

Although iron deteriorates by rusting, it can be recycled. The inventories of blacksmiths frequently refer to stocks of old iron. For the forges it was common to be fed with a mixture of scrap and new iron, too.

Two blacksmiths making horse-shoes (J. Amann 1568)

Recycling of clothing and clothing materials

The life of clothing materials – and especially traditional heavy woollen cloth – was long, and clothing frequently passed from one person to another: Masters would give old items of clothing to theirs workers. At death clothing was usually passed to a member of the family rather than destroyed. Some clothing passed from generation to generation. Many of these clothing were even not washed before the new owner wore them.

Washing of clothes and bedding was a lot of work. In many households the big washing only was done once a month, in others not so often. So many clothes and also the beddings were smelly and dirty. And the poor often did not have any clothes to change.

Washer-women (1910, Verlag Heinrich Möller Söhne, Rendsburg, Germany)

Prewash	• Chopping firewood
Day Before	• Sorting of the rags
	• Preliminary washing of the dirty clothes with soap
	• Lighting a fire and setting up the washing cauldron: water, detergent and then the white clothes, to soak them
Main Wash	• Bringing lye in the cauldron to the boil, the clothes are repeatedly pressed
Washing Day	under the water and moved
	• Hot clothes are lifted into a tub and there rubbed on the washboard and processed with soap and brushes
	• Clothes are rinsed in lukewarm water (which must also be heated)
	• At the stream/ river/ well/ washing trough, the clothes are rinsed cold until the water remains clear
	• The coloured clothes are placed in the hot lye in the tub etc. During this, the whites are bleeched on the grass
	• After approx. 3 hours, the clothes are turned over and once again dampened again with water
Bleeching	• The bleeched clothes must be drawn once again in a warm solution (cauldron)
	• The clothes are rinsed three times, wrung out and dried on the line
Washing Care	• Ironing and mangling

This need not mean that clothes had always been dirty. Not only towns but even the smallest village had wash-places or a wash-house at the riverfront or at a well, prosperous people could afford the services of washerwomen.
The life-span of a garment could be extended by different ways: they could be patched and turned; clothes were frequently cut down, altered, and refurnished silently at home. There has always been a trade in second hand clothing, and this trade caused great concern to the city's magistrates in time of plague: The removal, pawning and selling of clothing and bedding from infected houses was strictly forbidden. The contemporaries were quite right to suspect old clothes from "carrying" the disease. It is often suggested that the plague was carried from one town to another "in a box of old clothes". As the clothing was not washed very often, it is very likely that it still contained some pests – the role of the flea in the process of spreading the plague was not known.

A recycling product: paper

In one area of production all output depended on the re-use of materials: the paper industry. Its chief raw materials were water and rags. Mainly linen rags, old sheets, old clothing and the like were supplemented by old ropes and sails which were used for the manufacture of the poorer sort of paper. The paper industry grew substantially from 16th to 18th century and gave rise to a new trade – rag collection which offered causal employment for all sorts of poor persons. In some regions with paper mills, rags were so rare that they became smuggled goods.

Ragpicker (Museums of the City of Nuremberg, Graphical Collection: Ambros Gabler, ca. 1790)

The rags, the former clothing had often been worn for many years without any washing and it was a very unhealthy job to collect them. That was another reason why many epidemics appeared first at the paper mills.

The History of Recycling

	Fresh Water		Waste Water
Preparation Of Raw Material	Production Water	Rags • sorting • cutting • washing • rotting	
	Drive Power	crushing (mill)	Waste Water
Production	Production Water	Preparing fabric in the raking box/vat: • dipping out • pressing	 Waste Water
Processing	Production Water	• gluing • dyeing • smoothing • stacking	 Waste Water

The table shows that paper mills used a lot of water to purify the rags and thus heavily polluted the water. We have many historical records with complaints about water pollution in wells and streams, not only by the paper mills, but also by the tanners. But the intensity of that early water pollution was much smaller than after industrialization.

Conclusion

Recycling was of considerable importance to the economy of pre-industrial Europe. In a poor society, characterized by a substantial degree of both unemployment and underemployment, recycling had great value for the individual, and especially for the less fortunate. Those centuries could also be characterized as a "golden age of recycling". Comparing to industrialised societies, these societies produced little waste.

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The subject of recycling in the history Lesson

Where can the material best be used in the lesson? Because of the use of the English language, the material in unaltered form is only suitable for the sixth form lessons. Translated into the respective native language, however, it can certainly also be used for pupils from the age of 13. Knowledge of English is rarely evenly spread in all learning groups. It therefore makes little sense to make precise suggestions for working with the English material, regarding the best way it can be used in the lesson. Instead, the following suggestions for tasks should be given and discussion suggestions handed out, as to how the guidelines developed in the contribution "How to teach environmental history?" can be implemented in lessons in specific, practical terms. As regards the content, the main themes of scarcity and recycling fit in particularly well if they are dealt with shortly before the subject of industrialisation and/or the Industrial Revolution is dealt with. The subject of industrialisation may in any case already be included in the history curricula of most Baltic states. In contrast to the "Golden Age of Recycling", the revolutionary and epoch-making aspects of industrialisation stand out especially clearly

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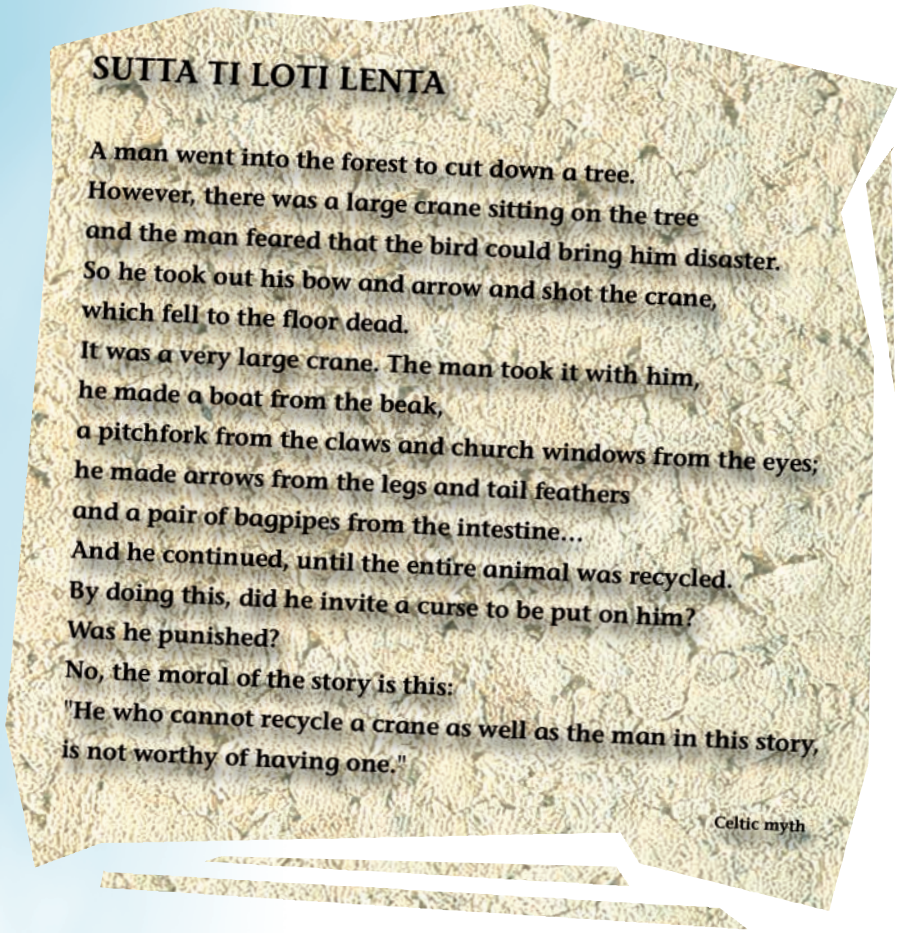

SUTTA TI LOTI LENTA

A man went into the forest to cut down a tree.
However, there was a large crane sitting on the tree
and the man feared that the bird could bring him disaster.
So he took out his bow and arrow and shot the crane,
which fell to the floor dead.
It was a very large crane. The man took it with him,
he made a boat from the beak,
a pitchfork from the claws and church windows from the eyes;
he made arrows from the legs and tail feathers
and a pair of bagpipes from the intestine...
And he continued, until the entire animal was recycled.
By doing this, did he invite a curse to be put on him?
Was he punished?
No, the moral of the story is this:
"He who cannot recycle a crane as well as the man in this story,
is not worthy of having one."

Celtic myth

against the centuries-old practices. Alternatively, the material can also be used as background content for a (history) project on the subject of "recycling". The task suggestions attempt to provide appropriate suggestions for both applications.

Introductory lesson
Together at the blackboard, the pupils produce a list of the environmental problems that they are aware of. One pupil takes the chalk and writes down what his fellow pupils compile under the direction of a second pupil. The teachers should here restrict themselves to only setting the pupils the task, and then – if possible – no longer intervening.

When listing environmental problems in groups, the subject of "waste" (here "rubbish heaps") almost always crops up, and is among the problems most often named by the pupils. Often in the discussion, the first insight already develops that most problems have several causes and cannot be easily solved.

Now, in the second step, comes the question as to what these environmental problems have to do with the subject of history. Are these not just contemporary problems? The pupils should now exchange ideas in partner work and develop

Example of a filled-in list (of an 11th year class)

Environmental Problem	Causes	Solutions
Greenhouse Effect	too much carbon dioxide	banning carbon dioxide
Ground Water Pollution	poisonous substances	reservoirs, collecting
Air Pollution	industry, households, cars	filter technology
Forest Dieback	car exhaust gases, acid rain	catalytic convertors
Rubbish Heaps	packaging	avoiding waste, recycling
Oil Pollution	supertankers	multiple hulls
Atomic Waste	atomic power stations	withdrawal from atomic power, alternative energy

hypotheses as to what the relationship between man and his natural environment looked like 300 years ago. They are here explicitly allowed to speculate, because this helps to reveal implicit assumptions and prejudices about how earlier societies dealt with nature. These advance assumptions are also written down on the board, in exercise books or better still on posters, so that they can be checked in the course of the following lessons. As a rule, the pupils express the idea of unspoilt nature, a life that was in harmony with nature but was also dependant on it. Here, it is especially important for the teacher to remain in the background and not to comment on the ideas of the pupils, but perhaps to ask for an example or for something said to be made more precise. Under no circumstances should the pupils already be contradicted here or their opinions be challenged.

Work suggestions

"Pre-industrial societies and the limits of growth"

1) What distinguishes the economies of pre-industrial societies from our present? Make comparisons and draw up a table. (Importance of agriculturally useful space? Energy supply? Where do raw materials come from? Limits of the growth?)
2) Using encyclopaedias or the Internet, find out about potash. What is potash? How was it obtained? Why was potash required for the manufacturing of glass, in the production for textiles and for doing laundry? (Also ask your chemistry teacher how it worked. You could perhaps produce potash yourselves and try out its effect?)
3) If one can characterise the pre-industrial societies as scarcity societies, what terms must one use to identify industrial societies and consumer societies? Look for and discuss suitable key words.

"The golden age of recycling"

Recycling in agriculture

1) Analyse the cycle of agricultural production. Describe how the cycle changed when additional fertilisers (such as the artificial fertilisers in the 19th century) were introduced.
2) Towards the end of the 18th century, more and more farmers started to grow potatoes. In comparison with cereals, potatoes require less space to produce enough to feed a family. What advantages were there for a farmer if he decided to grow potatoes instead of cereals?
3) Most cows and pigs in the pre-industrial era were very thin, with protruding bones, almost like the pictures that one sees from drought areas in Africa. Yet in the 19th century, the average slaughtering weight of cattle and pigs almost doubled. Explain!
4) Find out about old craft occupations using encyclopaedias and the Internet. How were leather, candles and soap produced? (You can perhaps also ask your grandparents, older neighbours or former craftsmen to help you with your answers?)
5) Using human faeces as fertiliser now seems very unappetising. Explain what drove people in pre-industrial times to recycle human faeces.
6) Even the cities were very closely connected with agriculture. As from the middle of the 19th century more and

more people moved to the cities, which became ever larger (urbanisation), new environmental problems arose there. In particular, the supplying of drinking water and the waste water required a new, large-scale technical solution: the sewerage system. What consequences did the construction of overflow sewers have for the previous connection between the city and agriculture?

7) Research task: When was a sewer first built in your local community? Since when have there been sewage plants and how well do these work? Can one visit them? (Very good information at the website of "The Sea and the Cities": http://www.valt.helsinki.fi/projects/enviro/)

Recycling of metals

1) Explain why metals are recycled especially often. (How were the metals originally obtained and what was required for this?)
2) In the pre-industrial era, iron ore was present in the ground in sufficient quantities in almost all countries and there were enough workers available. Explain why, nevertheless, only a limited quantity of iron was obtained.
3) From the middle of the 19th century, iron was smelted with hard coal, including outside Great Britain. More and more ironworks started to use hard coal for smelting instead of charcoal.
   a. Consider together what effects this had on the entire economy: on hard coal mining, the railways, on trades that continued to be reliant on charcoal, on wood prices and the labour market.
   b. What results did this changeover have from an environmental-historical perspective? What are the differences between hard coal and charcoal? Explain why some environmental historians have spoken of an "energy revolution".

Recycling of clothing and clothing materials

1) Explain the risks and disadvantages accompanying the re-use of used clothing in the pre-industrial era. Why were they still used?
2) Some of the things in the section on used clothing seem unhygienic, unsavoury, or even disgusting from a modern viewpoint. But poorer people in particular could not afford new clothing because they had either no money or not enough. Gather information on what work steps were necessary to e.g. produce a woolen jacket and how time-consuming this work was.
3) Gather possible explanations on the blackboard or on a poster as to why people in pre-industrial times tended to be willing to wear used items of clothing, even without washing them beforehand. Then discuss which explanations you find most convincing and why.
4) Earlier, as there were still no washing machines, washing was very hard work. Interview your grandparents or other old people on the subject of "washing in the past" (such an interview can also be conducted by telephone). Carefully prepare the interview with questions and always inquire further about anything that seems unfamiliar to you. Make a record of this interview. (How do the answers from male interview partners differ from those given by female interview partners? To what can these differences be attributed and are they inevitable?)

The History of Recycling

5) Clothing is now sometimes very cheap to buy. Why is this? (For this, see also the article "Recycling Jeans" in this book)
6) Worth asking: what happens nowadays with the clothing that is collected by aid organisations such as the Red Cross?
7) Organise a role-play. Two friends are arguing about second-hand clothing. Does clothing always have to be new?

A recycling product: paper

1) Summarise: how is pre-industrial paper production to be assessed from a health and ecological perspective?
2) Until well into the 19th century, rags were the most important raw material in the manufacturing of paper. These were then supplemented with wood fibres (mechanical wood pulp) and later replaced by wood pulp. Carry out research on the Internet and with environmental protection organisations: has this made the manufacturing of paper less harmful to the environment?
3) Paper was produced in almost all regions of Europe. Go looking for traces. Where did they use to be paper mills and paper makers? Which works still exist nearby and can also be visited?
4) In the art or chemistry lesson, you could also try to manufacture paper yourselves. You can find appropriate instructions in handicrafts literature or on the Internet.

For the concluding discussion:

1) Can one describe the pre-industrial era as a "golden age of recycling"? Consider arguments for and against, and justify your viewpoint.
2) In the introductory lesson, you developed hypotheses on the relationship of man and natural environment 300 years ago and made a record of them in exercise books or on posters. Examine these hypotheses critically, to see which of them are still tenable in light of your current knowledge and to what extent the others should be changed or rejected.
3) From an environmental-historical perspective, a society that re-uses a large part of the materials it uses seems something very positive.
   a. One could also see that differently. What aspects were less positive?
   b. Consider which other values you implicitly involved in your answer to the previous question. What perspective(s) does one adopt if one does not judge the pre-industrial era so positively? And with what adjective(s) could one name these perspective(s)?
4) In writing, explain whether or not you would like to have lived in a pre-industrial society.
5) Are general scarcity and supply bottlenecks absolutely necessary for a society to introduce an effective system for the recycling of resources? Or is poverty a necessary precondition for recycling things that others have thrown away? Take a critical approach.
6) Rich countries import raw materials and often also export part of their waste. Find out about the international trade in waste and the role your country plays in this.

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Our View on Recycling – from Then to Now

by Eliza Skrzyczek, Daria Tucholska and Aleksander Wosniak

Human beings, more than any other species, have dominated the Earth. Our planet faces a great hazard thanks to the man's activity which causes irrevocable harm. Our greed for its insufficient resources threatens everything from atmosphere to the fauna and flora life. One of the environmental threats is waste. An average human produces over 400 kilos a year. However, there is a method which allows reducing the amount of waste. It is recycling, which relies on receiving and transforming it once again. It has been gaining more and more popularity recently, because people start at last to perceive its great advantages.

Everybody should know that the natural environment is in a very bad condition and that our civilization produces a great number of aluminium cans, paper bags to be used only once and packages strengthened by aluminium and plastic. In the past this problem was solved by creating refuse heaps and by building combustions emitting dangerous toxins. Nowadays the situation changes, recycling becomes more and more popular so one should think about its beginning and its way of development.

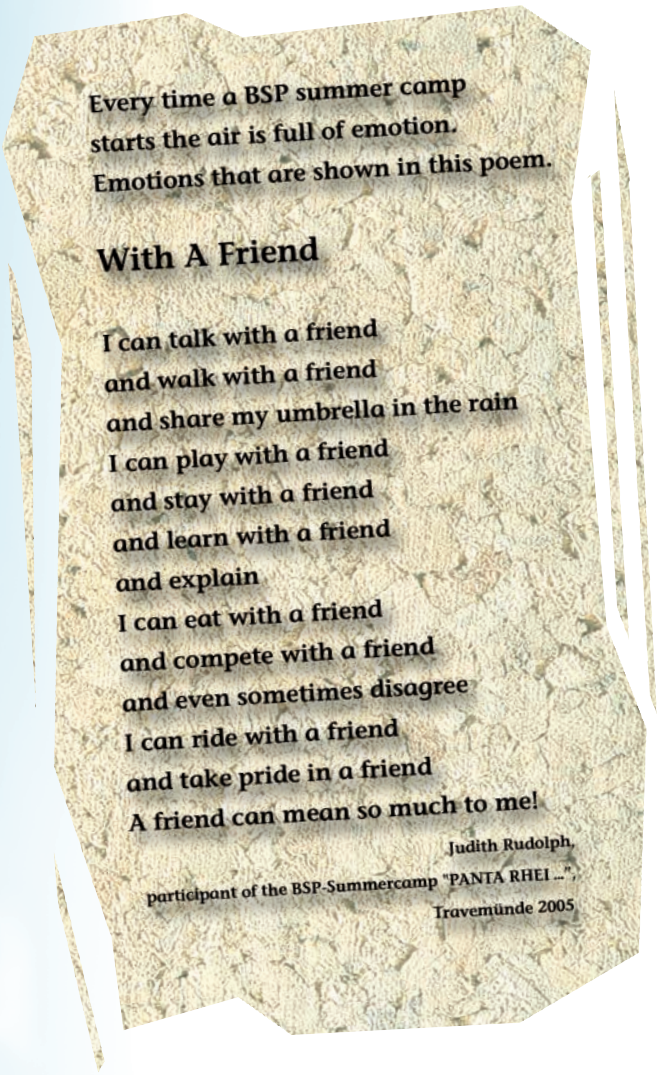
Historical Aspects

The beginning of waste management and recycling

Recycling, popular as it is today, isn't a new phenomenon: it's as old as the recorded history of mankind. Those who view recycling as a new "thing" will be surprised to find out that people have been doing it for hundreds, if not thousands of years. Here you will find a few important dates and events in the history of recycling and garbage management:

- 10,000 BC – Garbage becomes an issue as people first begin to establish permanent settlements.
- 400 BC – The first municipal dump is established in ancient Athens. In Mesopotamia, bricks from old buildings are recycled and reused for new ones.
- 105 AD – Ts'ai Lun invents paper made from plant fibres, fishnet and rags in China. This paper was used for writing, room decoration and clothing, still not as packaging material.
- 200 – The Romans create the first sanitation units. Teams of two men walk along the streets, pick up garbage, and throw it into a wagon.
- 1031 – In Japan waste paper was being re-pulped into new paper.
- 1388 – The English Parliament bans dumping of waste in ditches and public waterways.
- 1551 – The first recorded use of packaging; German papermaker Andreas Barnhart begins putting his paper in wrappers labelled with his name and address.
- 1690 – The Rittenhouse family establishes the first paper-recycling mill on the bank of Wissahickon Creek near Philadelphia: used cotton rags were remanufactured into paper.
- 1774 – The first method for recycling of used paper in Europe was invented by the German Martin Heinrich Kleproth by washing out the print ink completely from printed paper.
- 1776 – The first metal recycling in America occurs when patriots in New York City melt down a statue of King George III and turn it into bullets.

Fig.1: Plastic bottles and paper which can be recycled. Source: private



Every time a BSP summer camp
starts the air is full of emotion.
Emotions that are shown in this poem.

With A Friend

I can talk with a friend
and walk with a friend
and share my umbrella in the rain
I can play with a friend
and stay with a friend
and learn with a friend
and explain
I can eat with a friend
and compete with a friend
and even sometimes disagree
I can ride with a friend
and take pride in a friend
A friend can mean so much to me!

Judith Rudolph,
participant of the BSP-Summercamp "PANTA RHEI ...",
Travemünde 2005

- 1874 – The organized inclination to collect trash begins in Nottingham, England.
- 1885 – The first garbage incinerator in the US is built on Governors Island in New York City Harbour.
- 1897 – The first recycling centre is established in New York City.
- 1948 – Fresh Kills landfill is opened in Staten Island, New York. Later it became the world's largest city dump. It was closed in 2001, and since then it has been processed to be reintegrated into the nature. Fresh Kills and the Great Wall of China are the only man-made objects visible from space.
- 1970 – On April 22 the first Earth Day in the USA introduces the concept of recycling to the general public.

In European countries, especially in many former socialist countries, there have been founded recycling systems with the aim to motivate the inhabitants to bring old paper, carton, bottles, rags, etc. to special collecting points. Every returned kg of paper or every bottle was reimbursed to the inhabitants with a special amount. Recycling in the USA has taken off over the past 10 years as well, with greater participation than ever. It is interesting that New York City initiated a cursive recycling programme already in 1895, with residents separating their refuse into bins for organic materials, paper, ashes and general trash.

Early rubber recycling

A masticator
In Ohio in 1820 Charles McIntosh already needed more rubber than he could import just one year after he started producing raincoats with rubberised cloth. His re-

search partner, Thomas Hancock, came up with a solution. Hancock developed a machine to grind up scraps of rubber produced during the raincoat-making process. These shreds were then mashed into larger rubber blocks that could be fed back into the manufacturing process. Hancock called his machine a masticator because it essentially chewed the rubber scraps into smaller bits, but it was more widely known as "pickle".

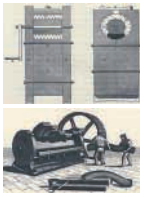
During the war

Wars have had a major influence on recycling throughout many countries' history. For example in the USA, George Washington and Paul Revere were those urged patriots to contribute old iron kettles and other scrap metals for reprocessing into armaments.

During the First World War, the federal government of the United States went so far as to create the waste reclamation service, which encouraged people to save old rags and waste paper, as well as to conserve natural resources as a whole. Many of our parents and grandparents will recall the extensive recycling programmes initiated during World War II. More than 20,000 "salvage" committees staffed by volunteers mobilised millions of people to set aside scrap iron, rubber and even kitchen grease for the war effort.

Earth Day

The most important event in the history of recycling is undoubtedly the "Earth Day". It is the representation of the long-standing tradition. For the first time the Earth Day was celebrated in the USA on 22 April in 1970. Its organisers wanted to initiate incentives for the Earth's physical and spiritual regeneration with one great common aim: to save our planet. The protection and renovation of the environment, facing the people's needs without destroying the environment were put as objectives to be achieved.



The diagram above shows a small, hand-cranked masticator. MacIntosh needed the industrial model, illustrated below. Source: http://www.dnr.state.oh.us/recycling/awareness/facts/tires/rubberrecycling.htm

The celebrations were met with unbelievable enthusiasm. Twenty years later this day is a holiday all over the world. In 140 countries 200 million people take part in marches, happenings and parades.

After 1970

The modern recycling movement has its start after the Earth Day in 1970. Dozens of non-profit recycling centres sprung up across America and then across Europe. Surely recycling isn't a passing fad, which is pointed out by the fact that it has been around a long time. It is the "disposable" mentality which is becoming "out of style".

The increasing interest in recycling in Europe and the USA caused its development also in Poland. Of course at the very beginning waste was stored on waste deposits or combusted. However, later many organisations and firms were created with the goal to watch over the environmental and recycling security.

Since Poland has become a member of the European Union, it has to adhere to strict environmental regulations and recycling quotas as every other EU-member state. In the sphere of recycling, every country has to implement the EU packa

Fig.2: Eliza Skrzyczek is conducting a survey with a passer-by. Source: private

Fig.3: Eliza Skrzyczek and Daria Tucholska are throwing bottles into the right container. Source: private

ging directive into national law that came into force in 1994 and was revised in 2004.

Recycling in Poland today

And how is the situation of recycling in Poland now? What do the Polish people think about it? To check that we searched for the most important information on the Internet and in books and we conducted a survey in the street among one hundred people between 18 and 30. You can find the results of the poll at the end of our article.

Waste separation

For several years we have been able to regain one tenth of glass bottles produced in Poland. Up to three quarters of the Polish people do not separate waste! This is not only the effect of the people's laziness, but also the lack of ecological consciousness. Fortunately, 52 % of the interviewees supported recycling and 42 % agreed that recycling was a good idea.

So where is the problem? Even willingness cannot help when there are no bins for recycling nearby. There are only 22,000 glass recycling bins in Poland. We need at least 100,000. Only 30 % of the local administrations efficiently solve the waste problem.

Packaging waste management

One of the most difficult is the issue of packaging waste. Theoretically, since the 1 January, 2001 we have had to regain at least half of the used packaging and to recycle a quarter. Unfortunately, the law is one thing but real life is another. In 2001, only 1 % of secondary materials (paper, glass and plastic) were used for recycling. These data are alarming. In January 2004 the packaging regulations appeared together with the definition of the small firms, which market the products in packaging subject to recycling.
According to the EU instructions, the quotas for recovery and recycling of the different sorts of packaging material will increase by the end of 2008: the level of glass and paper packaging recycling, for instance, should have reached 60 % in the old member states then; while to Poland and the other new member states a transition period till 2012 was conceded.
A newly created system in Poland emphasises the need for companies to gain interest in recycling packaging waste. New European Union regulations urge all the members to develop a new economy of waste materials.

The future perspective in Europe

The EU has to face a growing problem of waste management. Every EU citizen produces an average of 550 kg of municipal waste per year, thereof up to 30 % packaging waste. This by far exceeds the target of 330 kg set in the 5th EU-Environmental Action Programme in 1993. From our point of view, the EU's response to this waste problem and its environmental effects is incomplete and is inefficient up to now.

In 2003, the Commission launched broad consultations on a future thematic strategy for the prevention and recycling of waste. Once finalised, the paper will provide the regulation, a comprehensive review of the existing EU waste policy, which already comprises twelve directives, among them the packaging directive.The strategy is to be adopted as one amongst the seven outlined in the 6th Environment Action Programme.

The main objective of the thematic strategy is to decouple the use of

Our View on Recycling

resources and the generation of waste from the rate of economic growth. The Commission emphasises the need to develop the right mix of legislative, voluntary and economic instruments to achieve this objective.

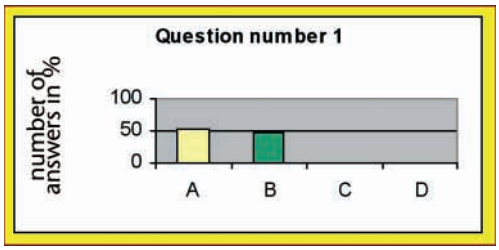
Recycling for the future

It is important to recognise the many economic and environmental benefits recycling already achieves. Recycling reduces the need for new landfills, prevents pollution, saves energy, supplies valuable raw materials to industry, creates jobs, reduces greenhouse gas emissions, stimulates development of greener technologies and conserves resources for our children's future. As we can see recycling has a very great impact on improving the environment we live in.

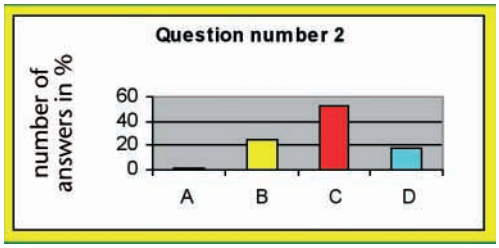
However, the most important matter about recycling is to start with education and communication on the issues while developing a "waste minimisation" mentality. Unfortunately, in highly consumer driven environments, it will take us a long, long time to change the way we think about the waste we generate and the resources we take for granted.
It is also important to build partnerships with the government, industry and the environmental community both at the European Union level and within the individual member states. There is a tremendous need and interest to provide consumers with information in their communities about the environment not only in Europe but also across the world.

The results of our poll

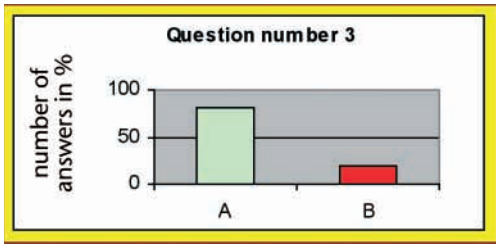
1. Complete the sentence. I…
a) am a super-supporter of recycling and ecology
b) think recycling is a good idea.
c) don't really pay attention to ecology.
d) am not sure what "ecology' means.



2. At home you…
a) recycle anything that can be recycled.
b) try to recycle things that can be recycled.
c) recycle a few things.
d) do not recycle at all.



3) Do you recognise the colours of the recycling containers?
a) Yes
b) No



"The earth will continue to regenerate its life sources only as long as we and all the peoples of the world do our part to conserve its natural resources. It is a responsibility which every human being shares. Through voluntary action, each of us can join in building a productive land in harmony with nature."

These are words of the former US-President Gerald Ford, which should become a kind of maxim for all of us. The environmental protection must become a priority of each country. We hope that in Poland it will be like that. After all, the future of our planet, of our country and our environment depends on us.

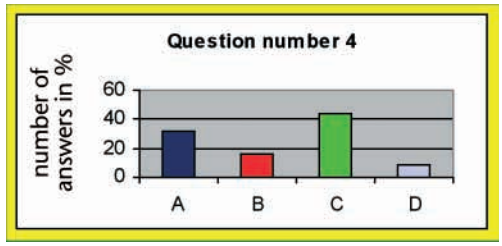
4) When used effectively, recycling programmes…

a) still cost more than regular trash disposal.

b) cost about the same as regular trash disposal.

c) can cost less than regular trash disposal.

d) never work right.



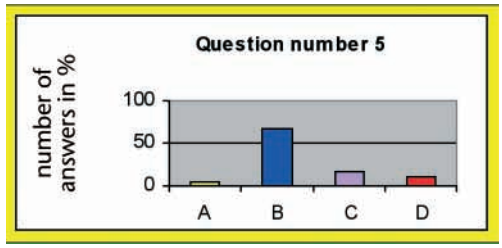
5) In your opinion:

a) Media give a lot of information about recycling.

b) Media don't have many recycling programmes and that's why a lot of people don't know what recycling really means.

c) Media are not interested in the issue of ecology and recycling at all.

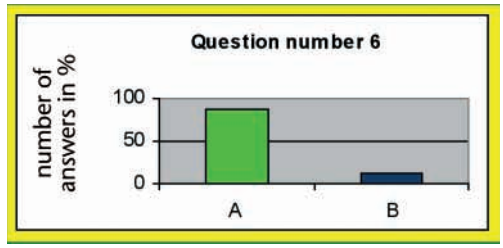
d) I don't know what the media attitude towards recycling is because I am not interested in it.



6) Have you ever taken part in the collection of paper and glass?

a) Yes

b) No



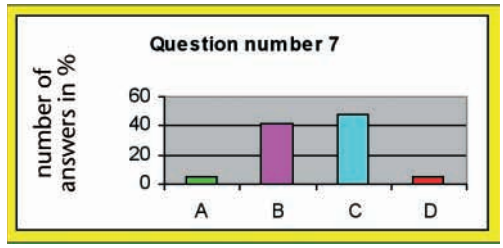
7) In your opinion contemporary people…

a) undertake many activities as far as environmental protection is concerned.

b) in some way try to take care of the environment.

c) do very little for environmental protection.

d) are not interested in environmental protection.



"The beauty of this earth inclines to me to call for its surviving for the future generations. If you love this native land may this calling not be left without the answer."

(John Paul II)

Our View on Recycling

Sources:

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- http://europa.eu.int/abc/doc/off/bull/en/200206/p104031.htm
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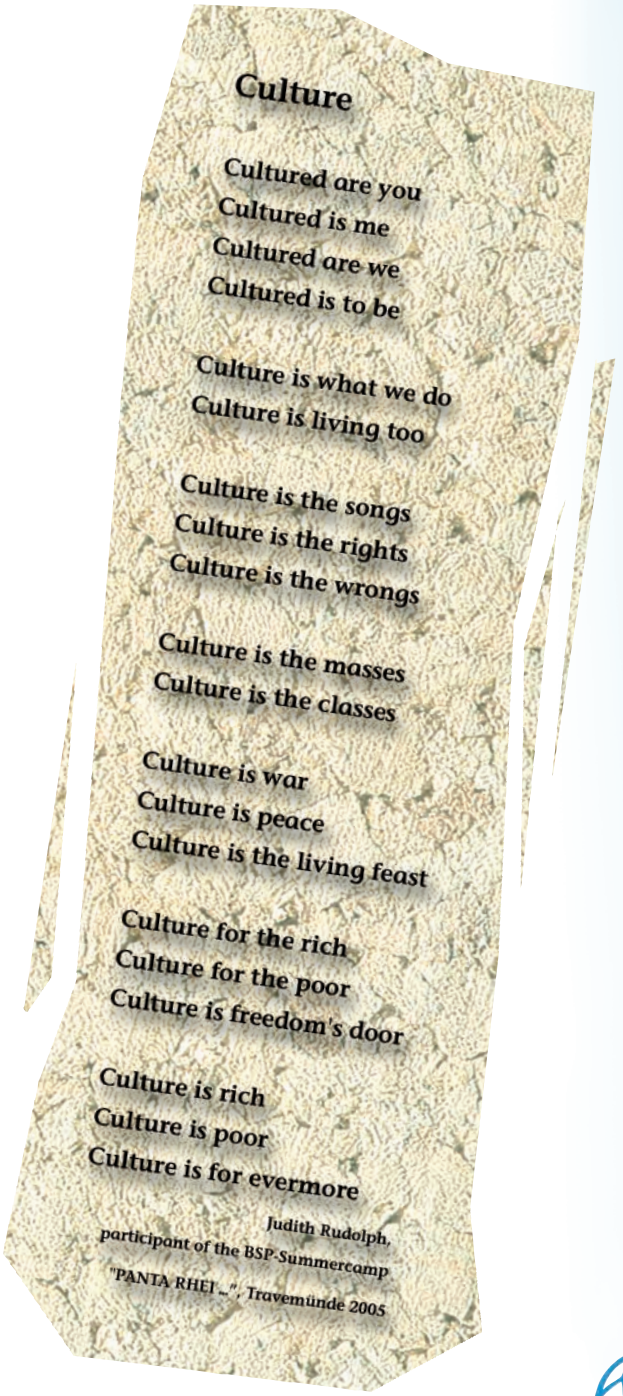


Culture

Cultured are you
Cultured is me
Cultured are we
Cultured is to be

Culture is what we do
Culture is living too

Culture is the songs
Culture is the rights
Culture is the wrongs

Culture is the masses
Culture is the classes

Culture is war
Culture is peace
Culture is the living feast

Culture for the rich
Culture for the poor
Culture is freedom's door

Culture is rich
Culture is poor
Culture is for evermore

Judith Rudolph,
participant of the BSP-Summercamp
"PANTA RHEI ~," Travemünde 2005

Kitubulu stream at the washing Bay.

Chapter 5: RESPOND

Mouth of Kitubulu stream. Background: Lake Victoria

No one "discovers" the future. The future is not a discovery. The future is not a destiny. The future is a decision, an intervention. Do nothing and we drift fatalistically into a future not driven by technology alone, but by other people's need, greed, and creed. The future is not some dim and distant region out there in time. The future is a reality that is coming to pass with each passing day, with each passing decision.

Leonard Sweet from SoulTsunami, 1999

Main source of Kitubulu stream.

Example: Car washing: The Impact of the Activity on a Stream and the Role of Wetland

by Isabella Ainobugabe, Elias Jetlee Kamusiime, Martin Mwesigwa and Aloysius Sserunjogi

One conspicuous and environmentally unsound activity along small streams and rivers and various water points in Uganda is car washing. This activity attracts persons of low educational background who migrate to urban areas seeking for source of livelihood.

The environment club and A-Level science students of Entebbe Secondary School. have been carrying out study to measure the impact of car washing on Kitubulu stream and the purifying role of the wetland. The inspiration for the study came from the book published by BSP Learners' Guide no. 4 "Working For Better Rivers"

Kitubulu stream has its origin from Kitubulu forest.

It crosses Entebbe – Kampala road at a distance of 9 km from Entebbe International Airport through a culvert and finally into Lake Victoria which is the second largest fresh water lake in the world. The amount of water in the stream varies with the wet and dry seasons. Before it enters the lake, the stream passes through a wetland.

The stream is a 20 minutes walk from school making it an ideal choice for environmental study methods included oral

interviews, questionnaires, observations, literature review and sampling.

The historical background of Kitubulu car washing bay dates from 1991 when the municipal authorities discouraged washing of vehicles in the lake. The most logical place to shift business was Kitubulu stream whose mouth was close to the point where car washing used to take place.The bay employs a maximum of 20 waters and caters for a minimum of 40 cars on average per day. Mostly soap and soapless detergents are used and these enter directly into the stream.

Three sampling points were selected:

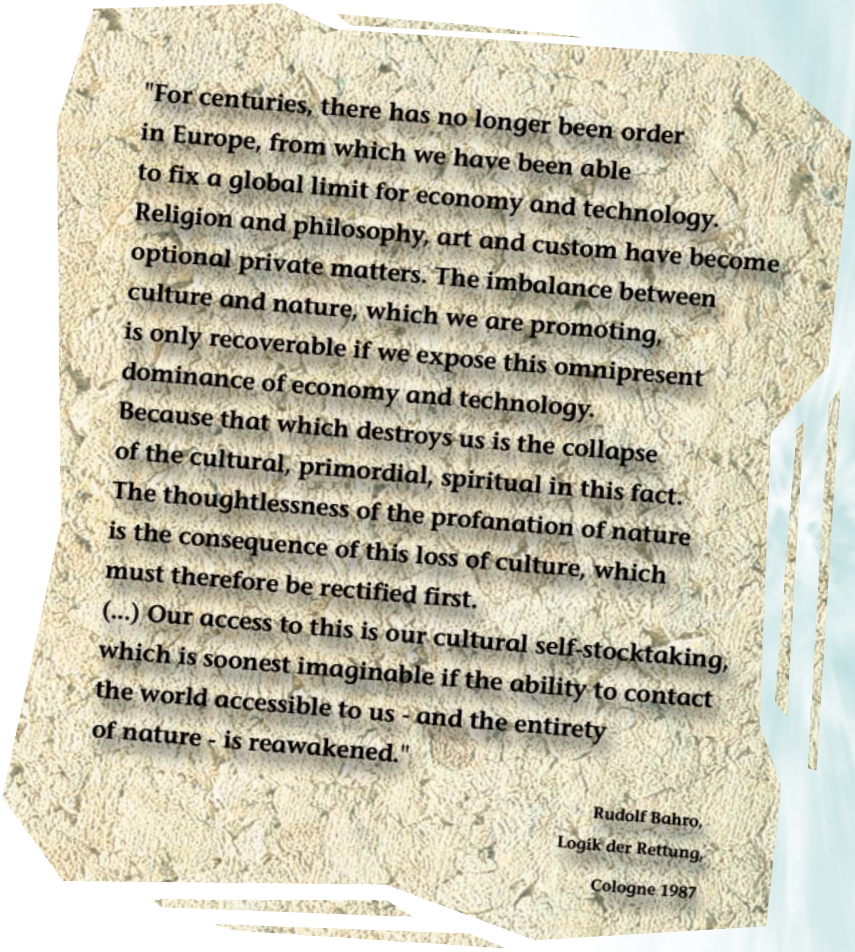
- The source of the stream
- A point at the washing bay
- A point after the wetland

Samples were collected using very clean bottles and tested at the National Environment Management Authority laboratory for phosphates, total dissolved solids (TDS), chemical oxygen demand (COD) and electrolytic conductivity (EC).

Conclusion

The level of phosphates was found to be high at the washing bay. The source of phosphates was basically soapless detergents used in washing. As the water passes through the wetland there was a drop in the amount of phosphates proving that wetlands can play a significant role in purifying water.

The high COD level and high EC and high value of total dissolved solids are due to the activities at the washing bay. Again these decreased after the stream had passed through the wetland. There was a



Part of mini wetland.

Stream emerging from the wetland. Vehicles lined up for washing at the bay.

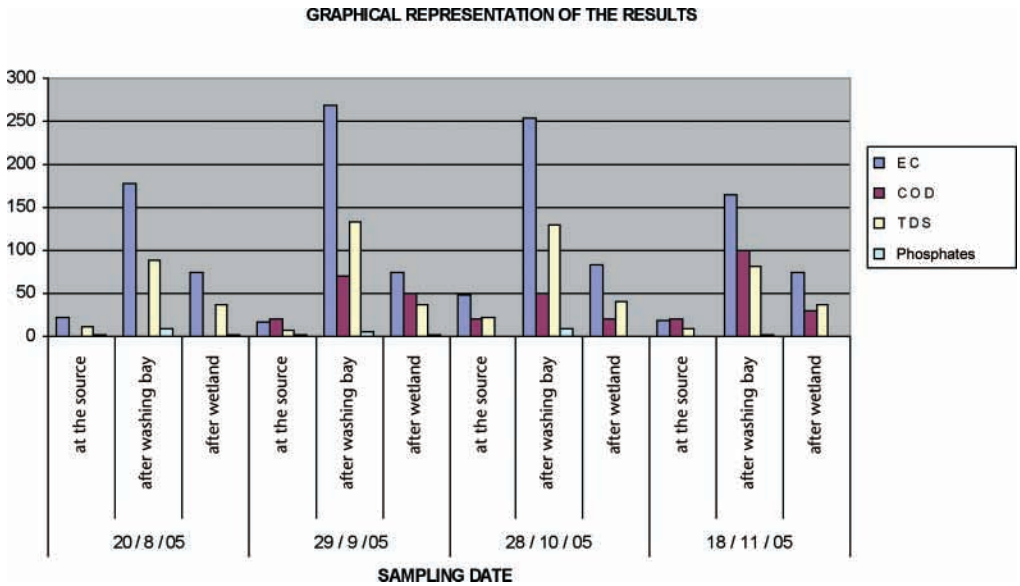
Cleared wetland by road construction. Kitubulu stream flows through the wetland.

clear difference in colour as dissolved solids became trapped in the wetland.

However, not all dissolved solids and suspensions were completely removed as water passed through the wetland. Also clearly visible at the surface of the water emerging from the wetland was a film of petroleum products. There is a limit to which this wetland can function in purifying dirty water from the washing bay.

There are many other washing bays other than Kitubulu, which introduce pollutants into Lake Victoria. Their combined effect could then become significant given that there may be no wetlands, as in the case of Kitubulu, to minimise introduction of pollutants. An African saying goes "One by one makes a bundle". There should therefore be greater concern in monitoring the effect of activities carried out along streams, rivers and in the lake.

Martin Mwesigwa (teacher)
together with the students
Isabella Ainobugabe, Elias Jetlee Kamusiime and
Aloysius Sserunjogi,
Entebbe Secondary School, Uganda



“When the wind of change is blowing,

some people build walls,

while others build windmills.”

Chinese wise saying

PANTA RHEI

and how to get it back

Deutsche
UNESCO-Kommission e.V.